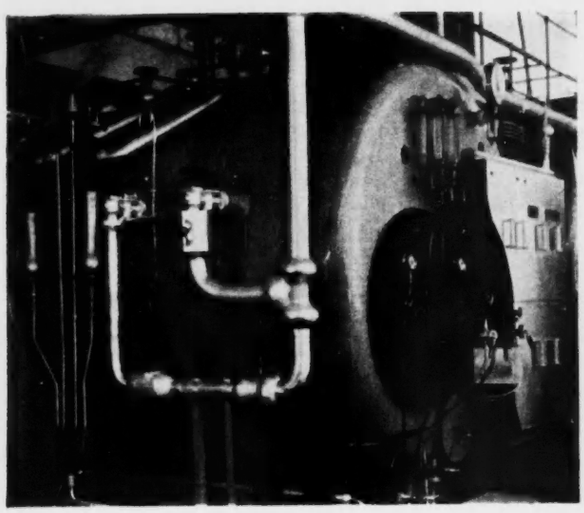
THE ENGINEER

MARCH 6, 1959 | 28 ESSEX STREET, STRAND, LONDON, W.C.2 | TWO SHILLINGS

Global Service to Industry



Central Boiler House, Sunbury Research Station: by kind permission of The British Petroleum Co. Ltd.

Throughout the world in almost every industry the companies of the Bell's Asbestos and Engineering Group have a service to offer. It may be the supply of auxiliary equipment for a boiler house or process plant; the complete thermal insulation of a land installation or ship; or it could involve the solving of a problem with the consequent design and development of "a special" to meet unusual conditions. Frequently it may simply be the supply of standard maintenance equipment.

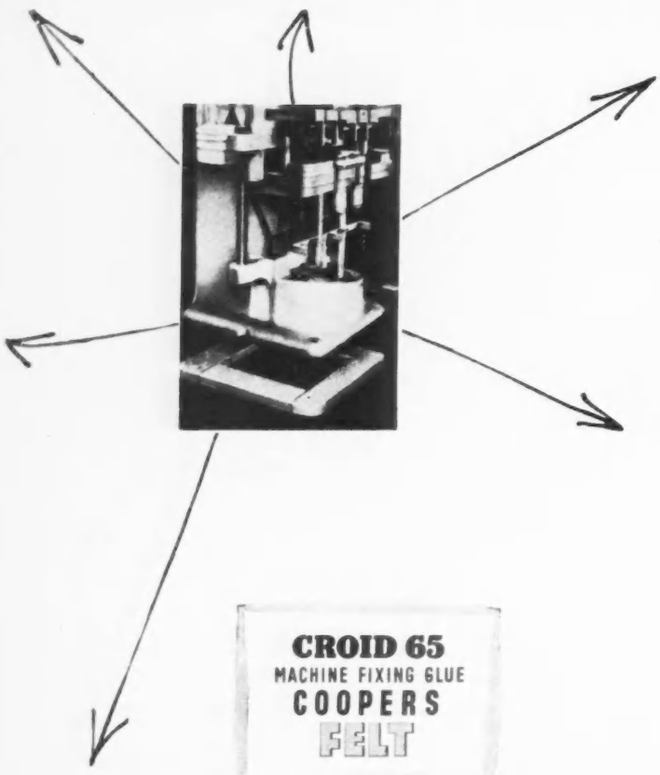
There are twenty companies within the group operating throughout the United Kingdom, in the Commonwealth and on the continent of Europe, with their own branches and warehouses —many have their own works; all are equipped to provide servicing facilities.

BESTOBELL

Full details regarding the services available within the Group may be obtained from:

BELL'S ASBESTOS AND ENGINEERING (HOLDINGS) LIMITED

Stoke House, Stoke Green, Slough, Bucks. London Office: 6/8 Upper Thames Street, E.C.4



PUT IT THERE....
OR THERE....
OR THERE....

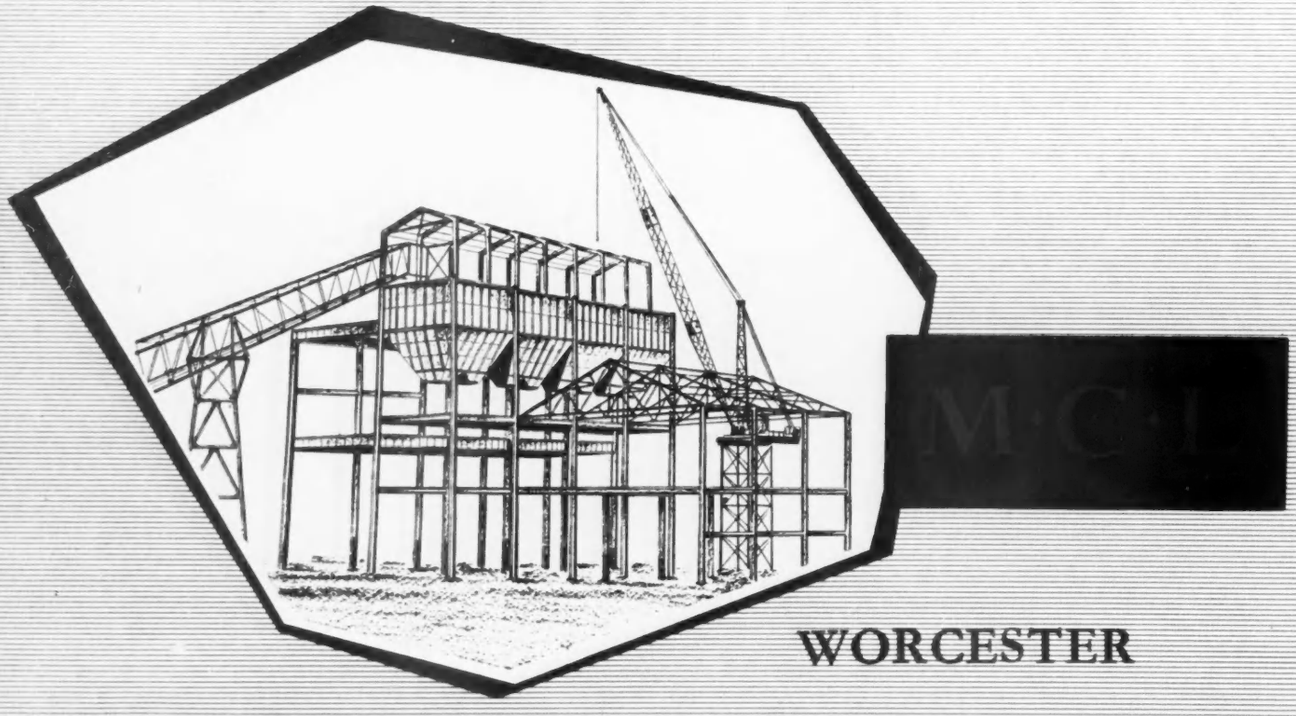
Imagine your machines stuck down on a felt base which can absorb over 80% of vertical vibration, which has a holding power of 50 lb. to the square inch, which does away with bolts, grouting, damaged floors. Then imagine deciding to change your layout when the workers have left one evening and having all the machines ready for action again in the morning. That's what Croid-Cooper can do for you. Send for details to-day.

COOPER & CO. (B'HAM) LTD., BRYNMAWR, BRECONSHIRE

TELEPHONE: BRYNMAWR 312

METAL CONSTRUCTIONS LIMITED

Structural Engineers



WORCESTER

THE ENGINEER

Established 1856

No. 5380 **MARCH 6, 1959** VOL. 207

EDITORIAL CONTENTS

Leading Articles

The Navy Estimates, 1959 . . . 365
Technology and Teachers . . . 365
On Making a Fuss of Graduates . . . 366
Preserving a Fen Pumping Engine . . . 367

Articles

100 Years Ago . . . 367
A. R. Payne — Shape Factors and Functions in Rubber Engineering. No. II . . . 368
Ore Carrier " Morar " . . . 370
Robson, Goodier & Penn — Fully Transistorised Frequency Modulated Indicator for Field Tests . . . 374
T. J. Williams — Pulsation Damping in Pressure Gauge Connections . . . 378
Ruston " AT " Diesel Engines . . . 384
Reconstruction of a London Underground Station . . . 386
Germanium Rectifier Factory . . . 387
Electronic Test Apparatus for Industry . . . 388
Convention on Plastics Technology . . . 388
Japan's First Atomic Power Station . . . 389
Double-Bolted Facing Points . . . 390
Technical Colleges and Research . . . 391
Highland Water Power . . . 391
Dry Dock Project on Tyneside . . . 391
Chapelcross Nuclear Power Station Starts Generating Electricity . . . 391
Oil Engine Manufacture . . . 392
Institution of Electrical Engineers . . . 392
Electric Furnaces . . . 392
Flexible Oil Barge Progress . . . 392
Radial Arm Saw . . . 393
Electronic Engineering Association . . . 393
Withdrawable Relays . . . 393
High-Pressure Flexible Hose . . . 393
New Trains for Metropolitan Line . . . 393
Astronautics Events . . . 393
Large Injection Moulding Machine . . . 394
Coiled Tinplate . . . 394
Automatic Correction of Telegraphic Errors . . . 394

Continental Section

Electrically Controlled Milling Machines . . . 396
French Observation Railcars . . . 396
Hot Water Ejector Wind Tunnel . . . 397
Large Surface Stress Tester . . . 397
Illuminated Weather Indicator . . . 397
Swedish Chipboard Factory . . . 397

American Section

Progress of the Tennessee Valley Authority. No. I . . . 398
Rotary Profile Tracer Lathe . . . 401

LETTERS — Why Restrict Output ? . . . 380
1959–60 Grid Tariff and Off-Peak Electricity Supplies . . . 380
The Use of Non-Dimensional Groups . . . 381

BOOK REVIEWS . . . 382

OBITUARY — W. J. Picken. R. A. Johnson . . . 383

NEWS AND NOTES — Industrial and Labour Notes . . . 395
Personal and Business . . . 402
British Patent Specifications . . . 403
Forthcoming Engagements . . . 404
Advanced Engineering Courses . . . 404

INDEX TO ADVERTISERS : PAGE 135 **CLASSIFIED ADVERTISEMENTS : PAGE 127**

NOTICE TO READERS No undertaking can be given to return illustrations or manuscripts. Correspondents are requested to keep copies. No notice is taken of anonymous communications.

SUBSCRIPTIONS U.K. and ABROAD £5 10. 0. p.a., including postage (CANADA £5 5. 0.). Single copies 2s. each, plus 9d. postage. Also on sale at newsagents.

'THE ENGINEER' BUYERS GUIDE Published annually. One FREE copy is sent to all direct postal subscribers on publication and delivered by newsagents to all regular readers. Additional copies are obtainable at 7s. 6d. each. Postage 1s. 9d. extra.

Published every Friday by

MORGAN BROTHERS (PUBLISHERS) LTD., AT 28, ESSEX STREET, STRAND, LONDON, W.C.2. Telephone : CENtral 6565

DRY AS DUST

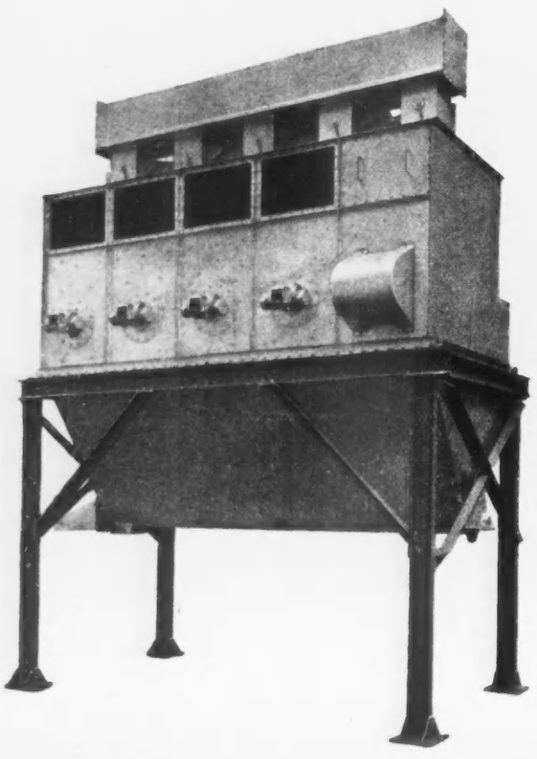
and just as unpalatable financially is the compulsory recovery of dust of no commercial value. Health and statutory reasons demand high efficiency collection and the new Visco "BERMAX" Automatic Dust Collector provides the most economical answer in high temperature conditions. Ask for full information.

THE VISCO ENGINEERING CO. LTD., STAFFORD ROAD, CROYDON. Telephone: CROYDON 4181

Visco "BERMAX"

Patent Automatic

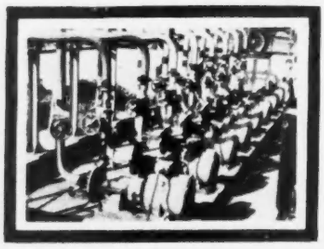
Dust Collector



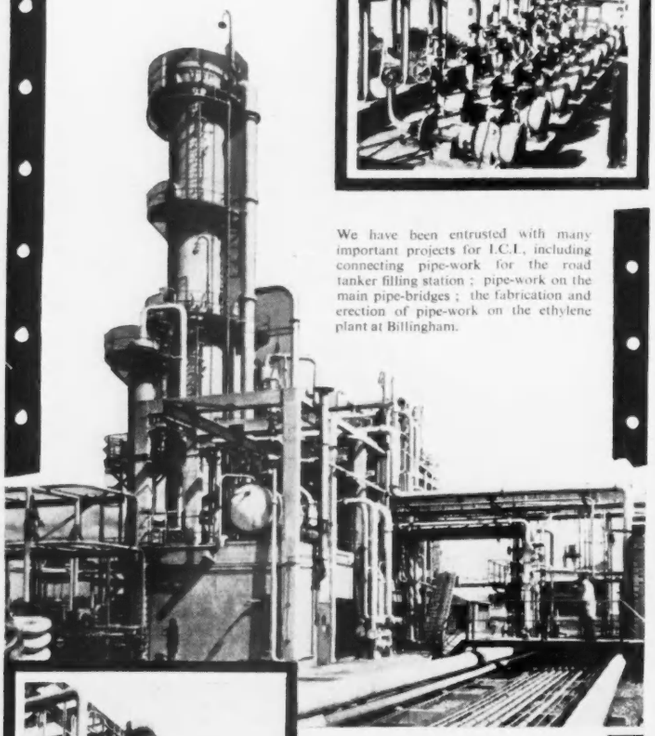
FWS

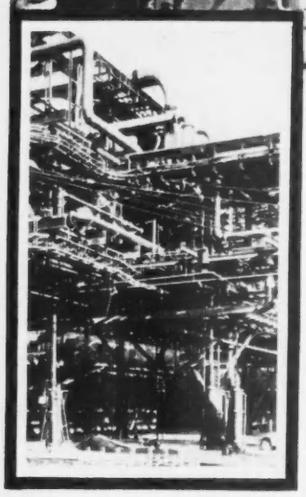
TANNAHILL

at I.C.I.



We have been entrusted with many important projects for I.C.I., including connecting pipe-work for the road tanker filling station; pipe-work on the main pipe-bridges; the fabrication and erection of pipe-work on the ethylene plant at Billingham.





Pipe-work problems become pipe-work achievements in the hands of Tannahill. It is no coincidence that many leading companies in British Industry to-day take time to talk to Tannahill *first* before embarking on any project of fluid, gas or steam handling. The Tannahill consultation service on pipe-work is in itself a revelation of what economies can be effected by skill, care and experience. Tannahill's knowledge of pipe-work erection is unique, having benefited from very wide experience in the field of chemical, fuel, power, petroleum and other industries. Tannahill fabricate pipe-work in mild and alloy steels, copper and aluminium in various ranges of pressure and temperature. Fabricate tanks, vessels, strainers, coils, calorifiers, condensers, separators; make flanges of all sizes, hangers, brackets, pipe supports, pipe-bridges of tubular or steel section and can offer immediate delivery of all normal classes and sizes of tube ex-stock.

The Tannahill technique means an easier, quicker and more economic approach to your projects.

take time to talk to

TANNAHILL

about fabricated pipework

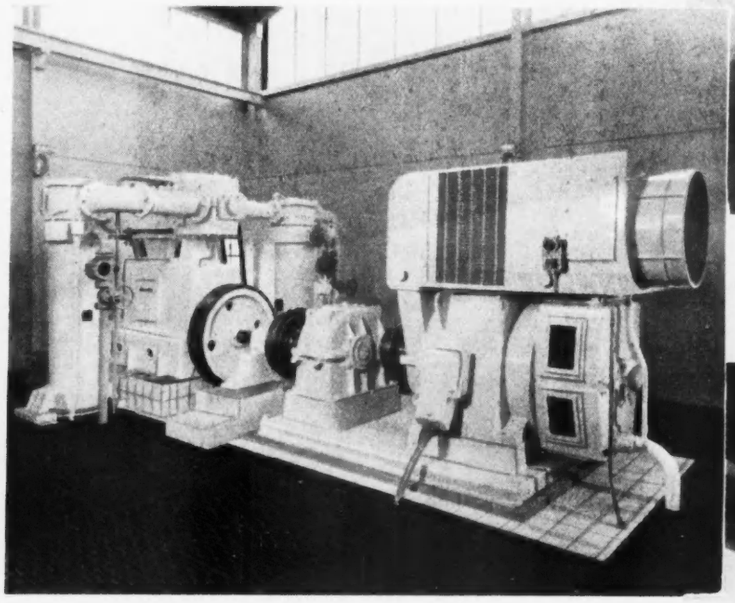
THOMAS TANNAHILL AND SON LIMITED

42-46 WATT ROAD, HILLINGTON, GLASGOW, S.W.2

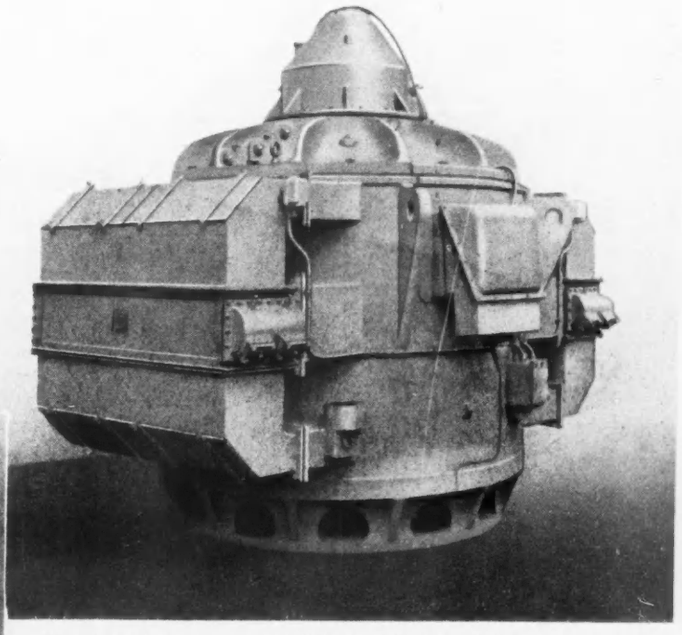
TELEPHONE HALFWAY 1655 TELEGRAMS TANSERVE GLASGOW, S.W.2.

LONDON ADDRESS: CLUN HOUSE, 17 SURREY STREET, STRAND, LONDON, W.C.2

L.S.E. CLOSED AIR-CIRCUIT MOTORS

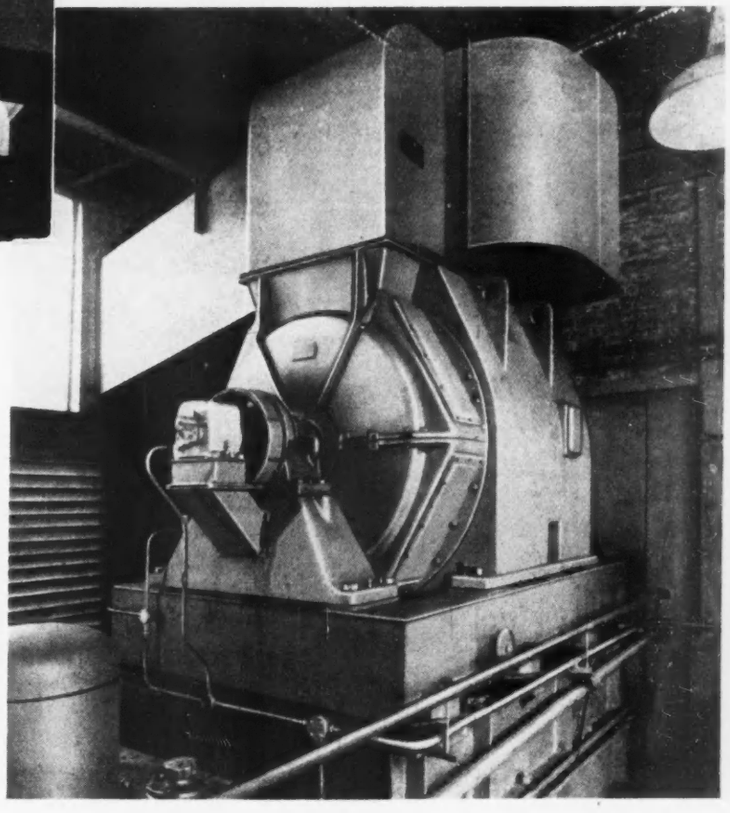


N–S variable-speed a.c. motor, 310/103 h.p. at 1080/360 r.p.m., driving Bryan Donkin compressor at Llanelly Gas Works. Pressurized closed air-circuit with air/air heat exchanger.



(Above) A "Trislot" motor of 1250 h.p., 595 r.p.m., 4000 volt, for pump drive. Closed air-circuit type with water cooler.

(Below) Slip-ring Induction Motor driving Sinter Fan (Barrow Iron Works). Rating 1380 h.p. at 743 r.p.m. Motor fitted with air/air heat exchanger.



L.S.E. have had extensive experience in the manufacture of closed air-circuit motors fitted with either air/air or air/water heat exchangers.

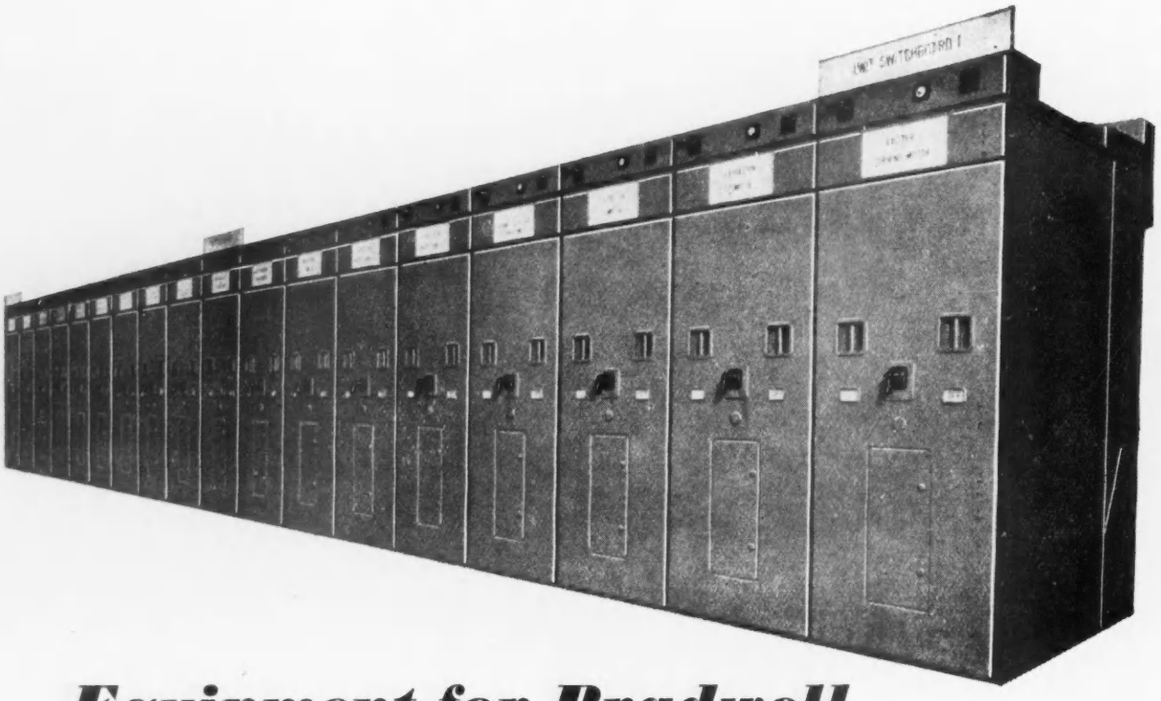
With this type of cooling, both constant and variable-speed motors can be constructed for any output likely to be required for industrial drives, powers of 5000–9000 h.p. being practicable.

Further details of this type of motor are contained in Publication 153 available on request from any L.S.E. branch or from: Publicity Department, Manfield House, 376 Strand, London, W.C.2.

LAURENCE, SCOTT & ELECTROMOTORS LTD.

SPECIALIST MAKERS OF ELECTRIC MOTORS AND CONTROL GEAR SINCE 1883.

NORWICH, MANCHESTER, LONDON & BRANCHES.



Equipment for Bradwell

All the switchgear comprising the main 132-kV air-blast circuit-breakers, 6·6-kV, 3·3-kV, and 415-volt air-break equipment for auxiliary supplies, together with its associated control apparatus for Bradwell Nuclear Power Station is being supplied by Reyrolle who are responsible also for the reactor control-rod heads, the fission-products detection equipment, and the machining of the graphite blocks.

Reyrolle specialists in switchgear and control-apparatus

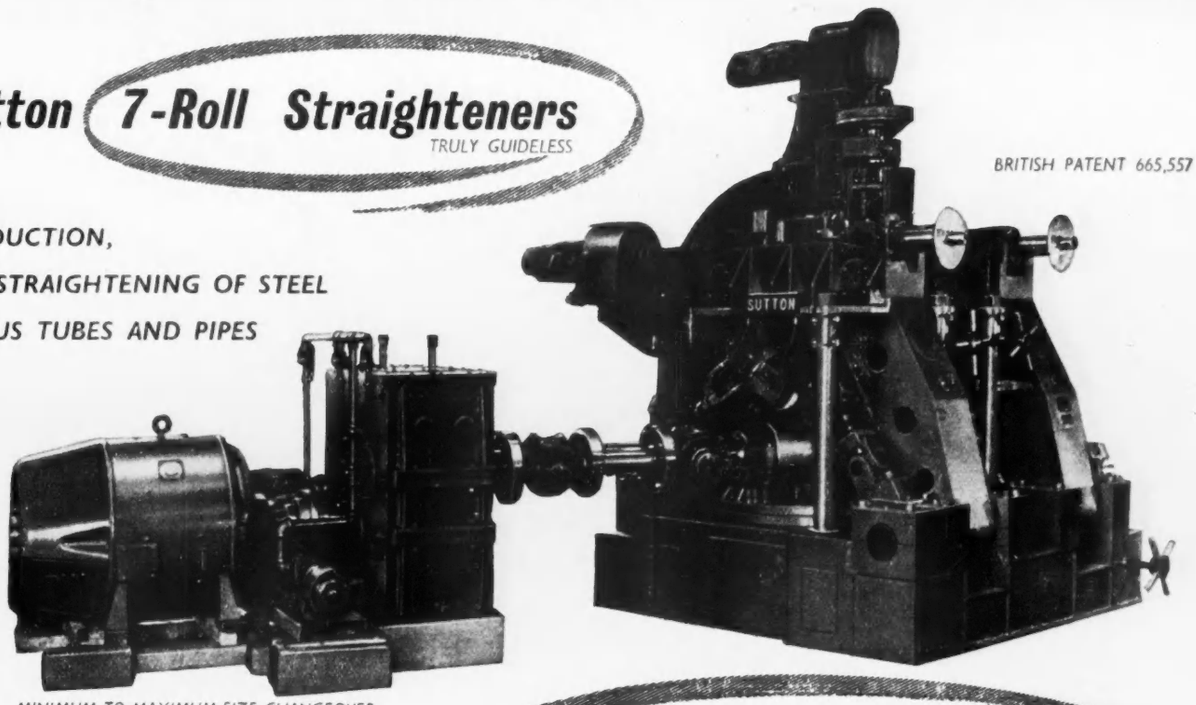
A. Reyrolle & Company Limited · Hebburn · County Durham · England

. . . . Sutton 7-Roll Straighteners

TRULY GUIDELESS

BRITISH PATENT 665,557

FOR HIGH PRODUCTION,
HIGH QUALITY STRAIGHTENING OF STEEL
OR NON-FERROUS TUBES AND PIPES



AVAILABLE IN
ALL SIZES FOR
5/16" TO 24" TUBES

Exclusive Features

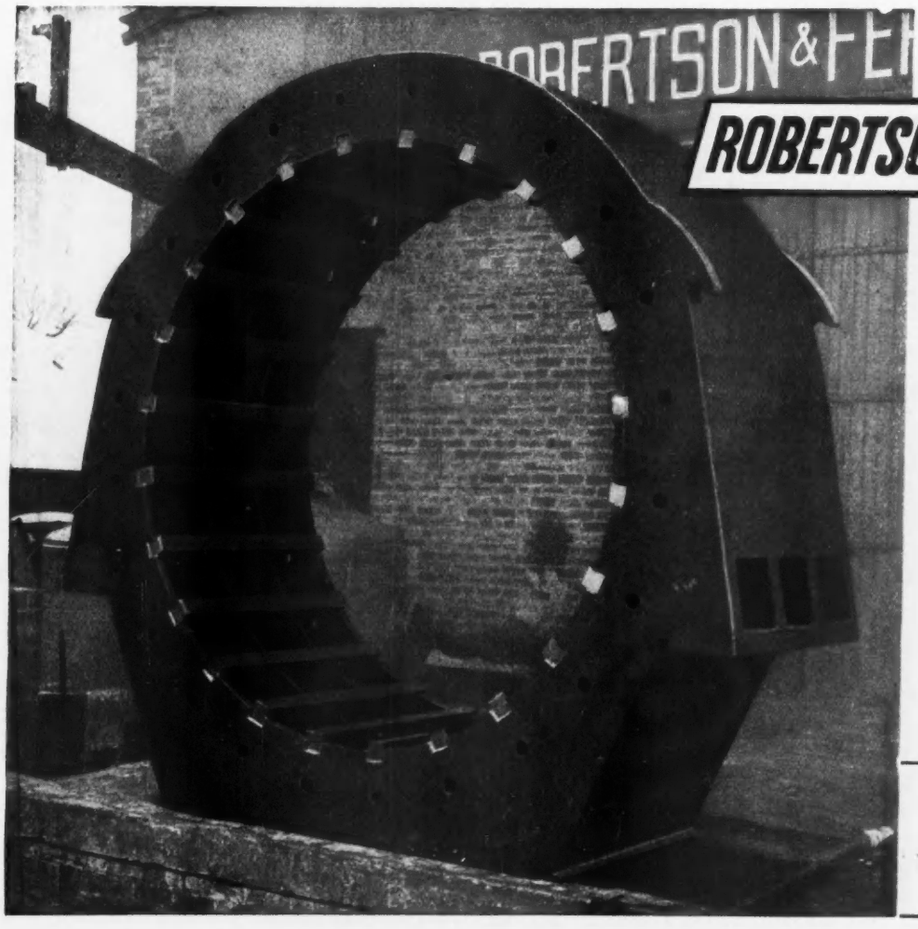
- MINIMUM TO MAXIMUM SIZE CHANGEOVER IN LESS THAN FIVE MINUTES.
- CONTINUOUS STRAIGHTENING OF TUBES AND PIPES, WITH OR WITHOUT UPSET ENDS.
- OPERATES WITHOUT GUIDES.
- CAN BE IN LINE WITH TUBE MILL.
- SPEEDS UP TO 800 FT. PER MINUTE.

NOW MANUFACTURED UNDER EXCLUSIVE LICENCE BY

FARMER NORTON

SIR JAMES FARMER NORTON & CO. LTD.

ADELPHI IRONWORKS, SALFORD 3, MANCHESTER
Telephone: Blackfriars 3613-4-5, 3692-3 Telegrams: "Agricola" Manchester.



ROBERTSON & FERGUSON LTD.

for General Fabrication in Mild Steels, Stainless Steels, Aluminium Alloys.

consult us at

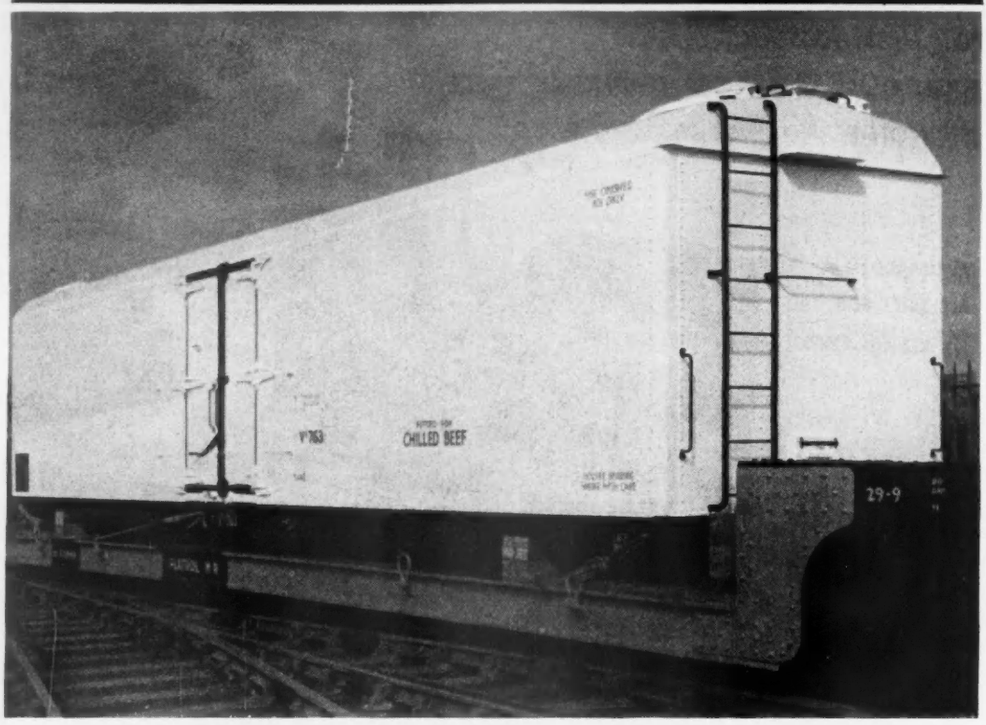
29 MURIESTON CRESCENT, EDINBURGH, 11 Phone: 68501/2/3

A Large Fabricated Mild Steel Stator Frame, with 1¾" thick endplates and 3" square core bars, constructed with a maximum of ¼" allowance on machined faces. Normal building allowances ± 1/16". Total weight 6¼ tons.

METRO-CAMMELL

REFRIGERATOR WAGONS FOR NEW ZEALAND

100 Refrigerator Wagon Bodies have been supplied by **METRO-CAMMELL** to the New Zealand Government Railways.

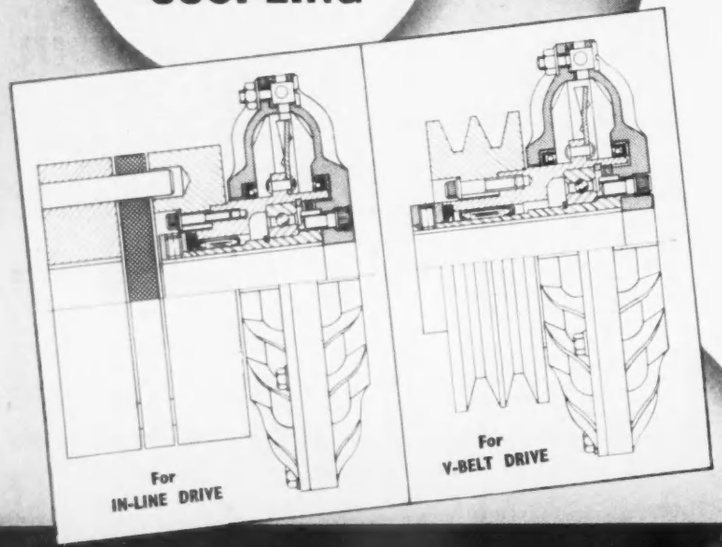


METROPOLITAN-CAMMELL CARRIAGE & WAGON CO. LTD.,

HEAD OFFICE: SALTLEY, BIRMINGHAM, 8 · LONDON OFFICE: VICKERS HOUSE · BROADWAY · WESTMINSTER, S.W.1

THE DRY FLUID CENTRIFUGAL COUPLING

– a new 6 point approach to POWER TRANSMISSION PROBLEMS



1. Starts high loads smoothly with smaller power units and eliminates the starting snatch which is often troublesome in the papermaking, wire, printing and textile industries.
2. The necessity of using electric motors with high starting torque characteristics together with expensive switchgear is eliminated.
3. Prolongs the life of chain or V-belt drives and other components associated with the transmission of mechanical power.
4. Invaluable for power factor correction problems, as it reduces peak electrical loadings.
5. Can be made to slip at a predetermined overload and so prevent damage to a power unit.
6. At full load/speed almost 100% efficiency is obtained (one revolution slip per 10,000 revolutions).

SPECIAL DESIGN FEATURES

(i) Ball and roller bearing races used between the inner and outer hub members.
(ii) Mechanical type, Neoprene rubber seals.
(iii) Couplings can be used for either in-line or belt drives and a pulley or flange can be fixed direct to the outer driven member via the medium of bolts.

If you require further information or have a transmission problem, please communicate with:

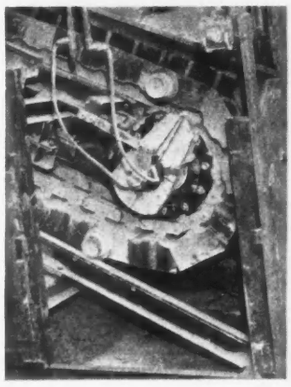
POWDER COUPLINGS LTD.,
20 BLACK BULL STREET, LEEDS, 10
Telephone: LEEDS 20936 & 31471/7

PATENT CATENARY CONVEYORS

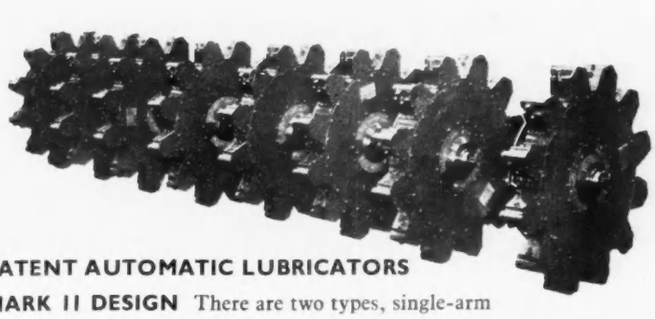
AND LUBRICATORS

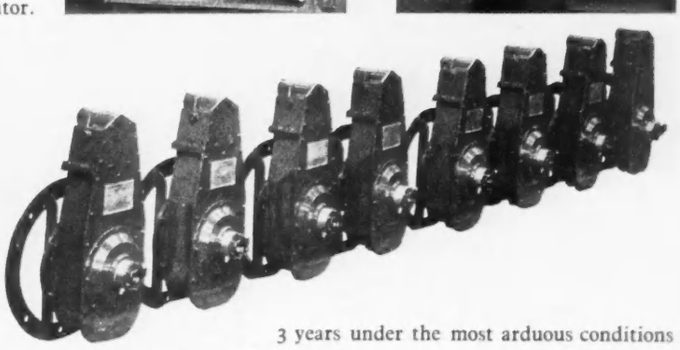
This conveyor, installed in the Cauldon Cement Works of Messrs. G. & T. Earle & Co. Ltd., has been running for 18 months, 24 hours per day and, to quote a letter from the Company, "has given every satisfaction." **Dimensions:** 24″ x 10″, approximately 300′ long, last 200′ having an incline of 30°. **Duty:** 80 T.P.H., 25 F.P.M., 20 H.P.

This conveyor, fitted with our automatic chain lubricators, is installed in the Rodmell Cement Works of Messrs. Associated Portland Cement Co. Ltd. and has been running for 9 months, 24 hours per day. Their Works Manager has expressed his complete satisfaction with performance of conveyor and lubricators. **Dimensions:** 18″ x 6″ x 45 T.P.H.



An 18″ x 10″ x 450′ centres x 100 T.P.H. conveyor has since been supplied to Messrs. Associated Portland Cement Co. Ltd., for White's South African Portland Cement Co. Ltd. Lichtenburg Works and orders are on hand for two 40″ x 10″ catenary-type x 60′ centres continuous elevators and two 18″ x 5″ conveyors for their Johnsons Works, to be fitted with our latest type of lubricator.



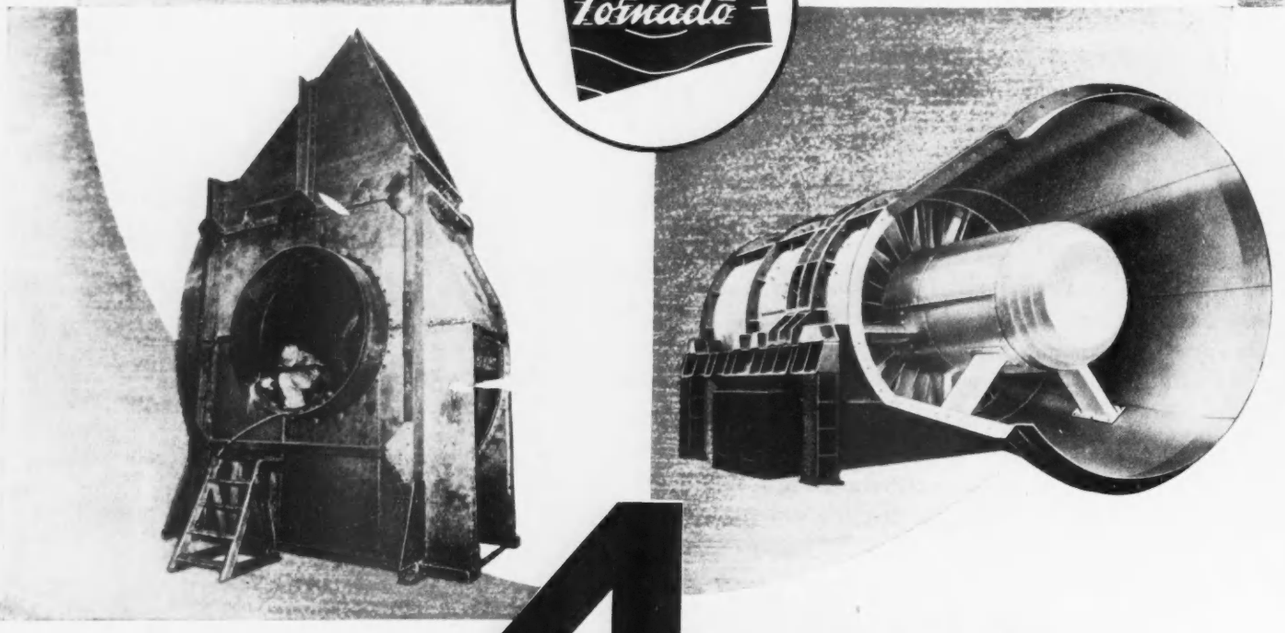


PATENT AUTOMATIC LUBRICATORS MARK II DESIGN There are two types, single-arm and multi-point, as illustrated, both of which give effective lubrication of chain and outboard rollers with the absolute minimum of attention and unskilled operation. Mark I prototype has been in operation for 3 years under the most arduous conditions in the Hope Cement Works of Messrs. G. & T. Earle & Co. Ltd. Both types have been exported in quantities for elevators and pig casting machines.

CLARKE, CHAPMAN & COMPANY LIMITED
VICTORIA WORKS,
GATESHEAD CO. DURHAM

Clarke Chapman

LONDON OFFICE:
Dunster House, Mark Lane, E.C.3.
GLASGOW OFFICE: 116 Hope Street, C.2.
MANCHESTER OFFICE: 8 King Street, 2.



4 FANS

from the world's widest range

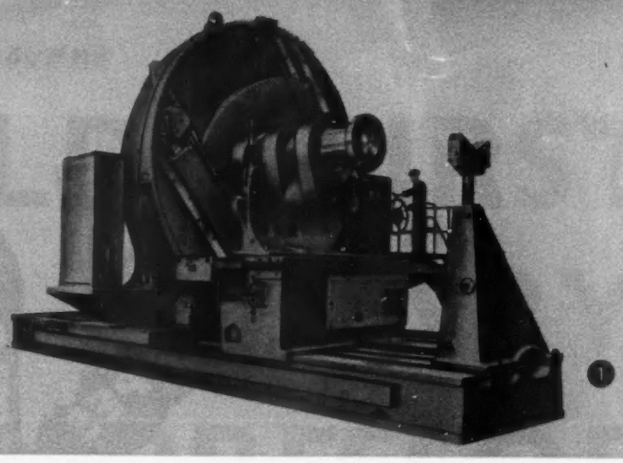
BY MANUFACTURERS OF FANS FOR INDUSTRY SINCE 1883

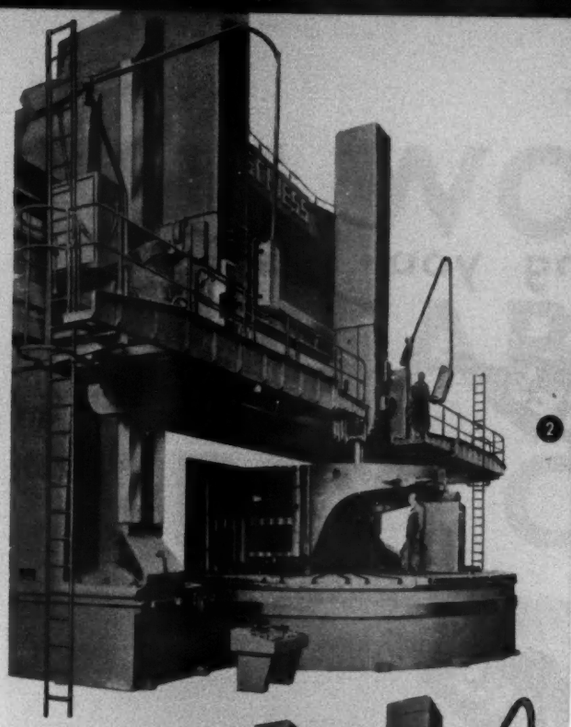
Ask for fully illustrated Publication 25/1
"Heavy Fan Engineering". It covers the large and heavier classes of equipment in the 'Tornado' range including

CENTRIFUGAL FANS · MILL EXHAUSTERS
INDUCED DRAUGHT FANS · ALTERNATOR COOLERS
PRIMARY AIR FANS · GAS BOOSTERS · TURBO BLOWERS
AXIAL FANS · MINE VENTILATING FANS

Keith Blackman Ltd. MILL MEAD ROAD, LONDON N.17 Tel: TOTtenham 4522
(incorporating Blackman Export Co. Ltd.)
and at BIRMINGHAM · BRISTOL · GLASGOW · LEEDS · LEICESTER · MANCHESTER · NEWCASTLE-ON-TYNE

887



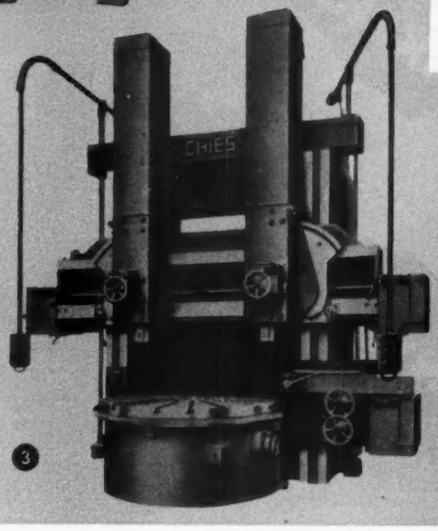


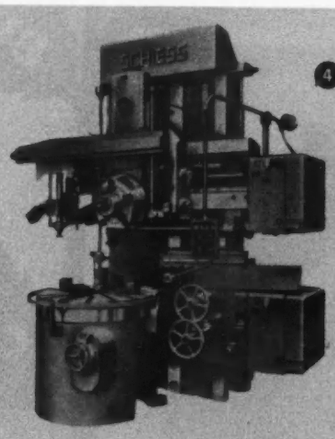
Your Large Scale Production Plans

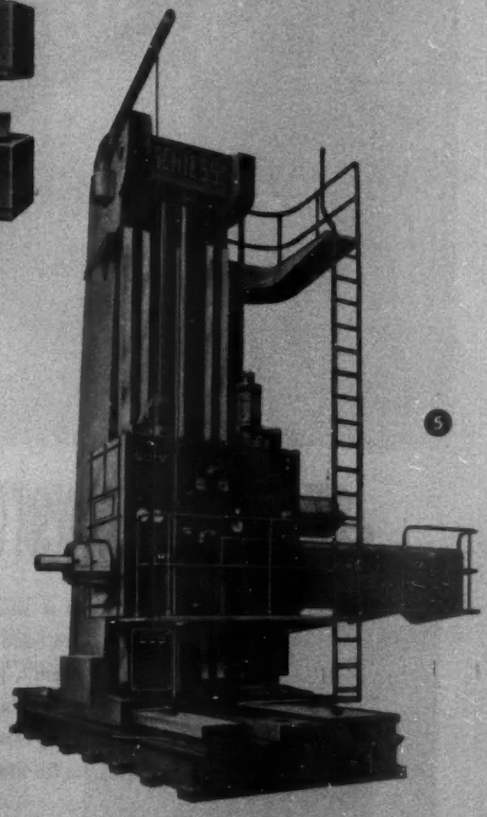
will quickly take shape with

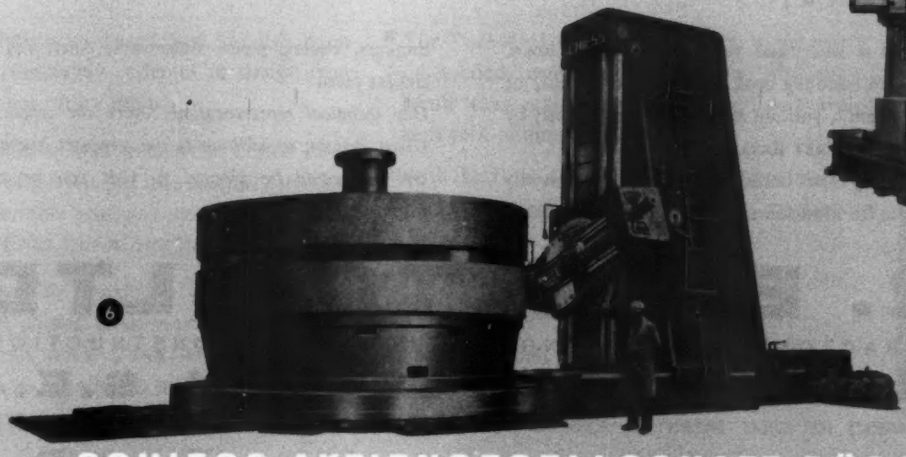
SCHIESS

High performance machine tools









1. Crankpin Turning Machine KZA 285, with 112in. i.d. of ring
2. Giant Vertical Boring Mill 26 GK 800/1000, with dual table. Maximum turning diameter 394in.
3. Double Column Vertical Boring Mill KZ 200. Maximum turning diameter 79in.
4. Single Column Vertical Turret Lathe KE 100, with copying device. Maximum turning diameter 39in.
5. Horizontal Milling and Boring Machine FB32/19, with 12⅝in. milling spindle and 7⅛in. boring spindle.
6. Precision Gear Hobbing Machine RF 40/60 S, shown with finish machined 157in. dia. marine turbine gear for transmitting 16,000 H.P.

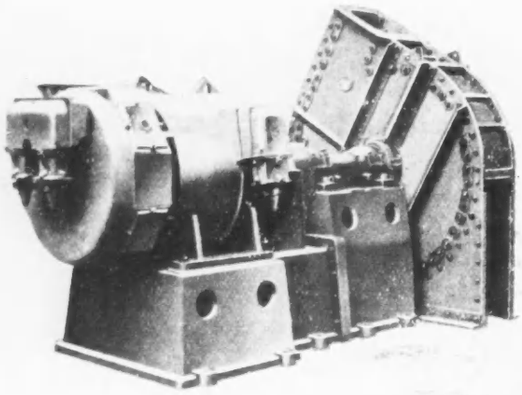
SCHIESS AKTIENGESELLSCHAFT DÜSSELDORF

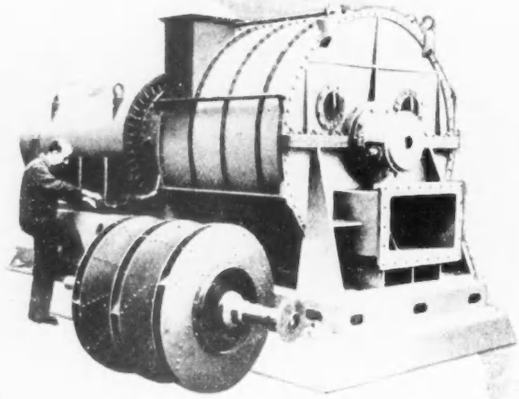
6230

Agents United Kingdom and Eire, **BURTON, GRIFFITHS & CO. LTD. BIRMINGHAM**

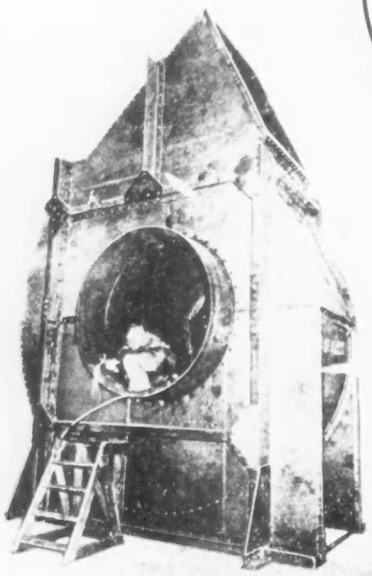
SYKES MACHINE TOOL CO. LTD. THE HYTHE, STAINES, MIDDLESEX

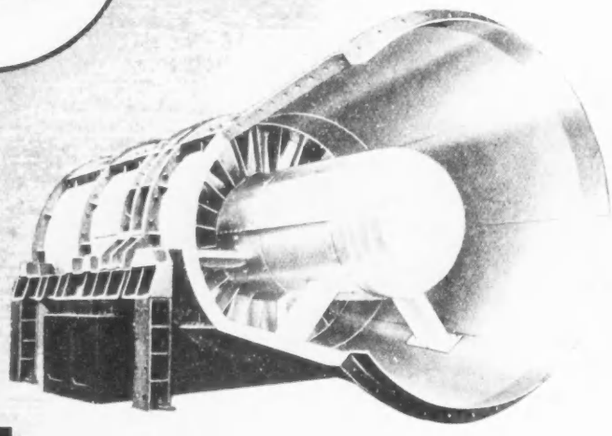
(For Gear Manufacturing Machines)





Tornado



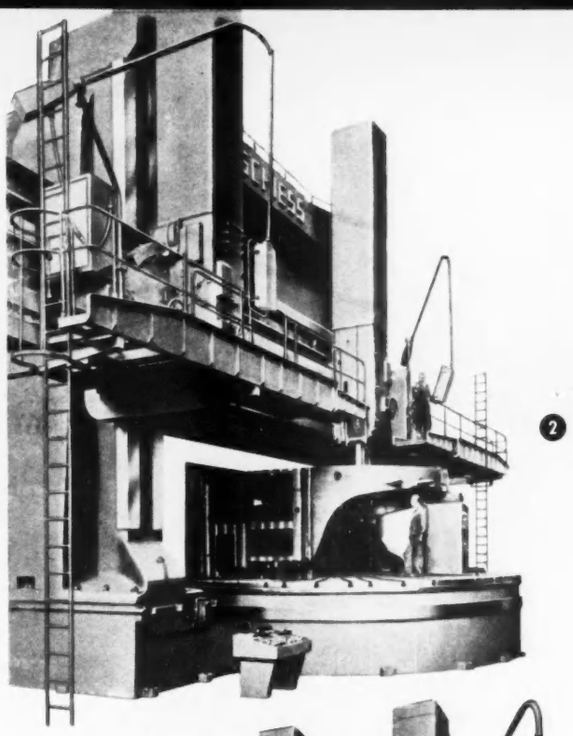


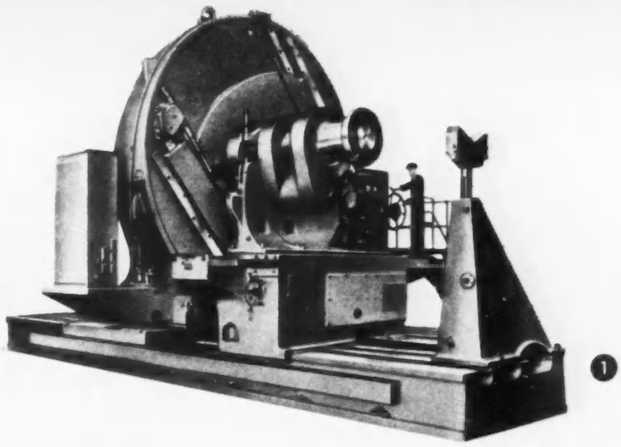
4 FANS

from the world's widest range

CENTRIFUGAL FANS · MILL EXHAUSTERS
INDUCED DRAUGHT FANS · ALTERNATOR COOLERS
PRIMARY AIR FANS · GAS BOOSTERS · TURBO BLOWERS
AXIAL FANS · MINE VENTILATING FANS

Keith Blackman Ltd. MILL MEAD ROAD, LONDON, N.17. Tel: TOTtenham 4522

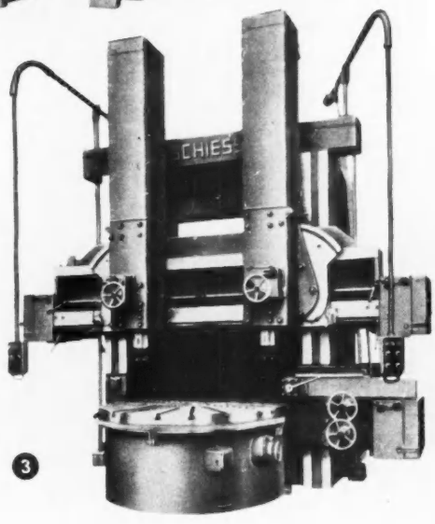


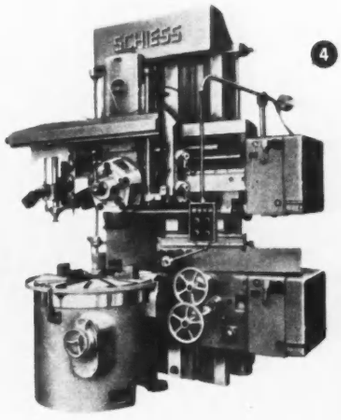


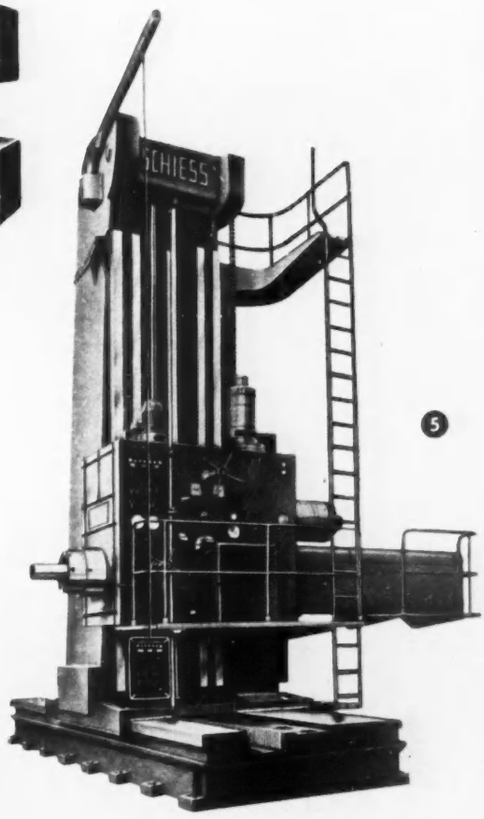
Your Large Scale Production Plans
will quickly take shape with

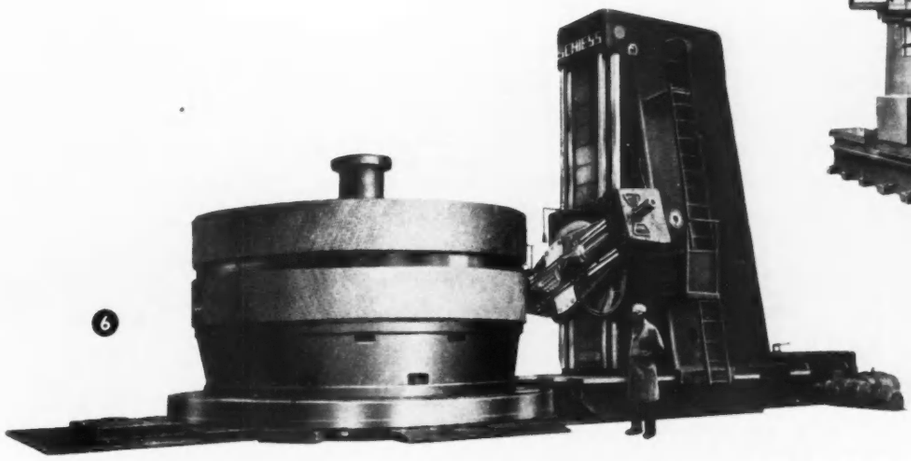
SCHIESS

High performance machine tools









1. Crankpin Turning Machine KZA 285 with 112in. rd. of ring.
2. Giant Vertical Boring Mill 26 GK 800/1000 with dual table. Maximum turning diameter 394in.
3. Double Column Vertical Boring Mill KZ 200. Maximum turning diameter 79in.
4. Single Column Vertical Turret Lathe KE 100 with copying device. Maximum turning diameter 39in.
5. Horizontal Milling and Boring Machine FB32.19 with 12½in. milling spindle and 7in. boring spindle.
6. Precision Gear Hobbing Machine RF 40.60.5 shown with finish machined 157in. dia. marine turbine gear for transmitting 16,000 H.P.

6230

Agents for Sales, Service and Spares: **BURTON, GRIFFITHS & CO. LTD. BIRMINGHAM**

SCHIESS MACHINE TOOL CO. LTD. THE HYTHE, STAINES, MIDDLESEX

(For Gear Manufacturing Machines)

is ABRASION eating your plant ?

combat ABRASION with *Fused Cast Basalt*

Abrasion is wear, and wear keeps profits down. If you are handling coal, coke, ash, ore, dust, or other minerals, you can reduce wear enormously by using FUSED CAST BASALT.

It is easily the hardest material commercially available for abrasion-resisting linings for hoppers, bunkers, chutes, pipes, sluiceways, conveyors or similar plant.

Our technical representation covers the whole of Great Britain, in addition to our overseas interests, and we would be pleased to visit you or send literature upon request.

THE RBH GROUP

R. B. HILTON LTD

REFRACTORY, INSULATING & SPECIALIST CONSTRUCTIONS

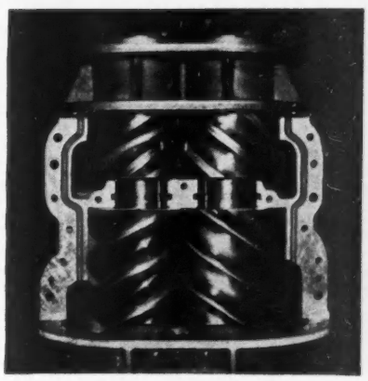
BLACKHEATH, LONDON S.E.3

SOLE AGENTS FOR GREAT BRITAIN FOR SCHMELZBASALTWERK KALENBORN | ***TELEPHONE:*** **LEE GREEN 4512/6**

THE WORLD'S FIRST PORTABLE ROTARY SCREW COMPRESSOR

THE ATLAS COPCO TWIN-AIR

- This Compressor—based on a Swedish invention—is completely different in design from conventional rotary types.
- After extensive field tests Atlas Copco *Twin-Air* Portables were put into quantity production earlier this year and were first exhibited at the St. Eriks Fair in Stockholm last August.
- These Portable machines embody all the know-how gained from two years operating experience with *Twin-Air* Stationary Compressors installed in mines and industrial plants.
- The *Twin-Air* has no wearing parts in the two oil-flooded compression chambers, with the result that maintenance and overhauls are kept to a minimum.
- With the *Twin-Air* you get an overall operating efficiency which only a two stage machine can give.
- The Rotary Screw design guarantees a smooth air-flow, free from surging characteristics.
- The first models in this new range are machines of 370 c.f.m. and 620 c.f.m. Both 100% air-cooled, diesel-powered units.

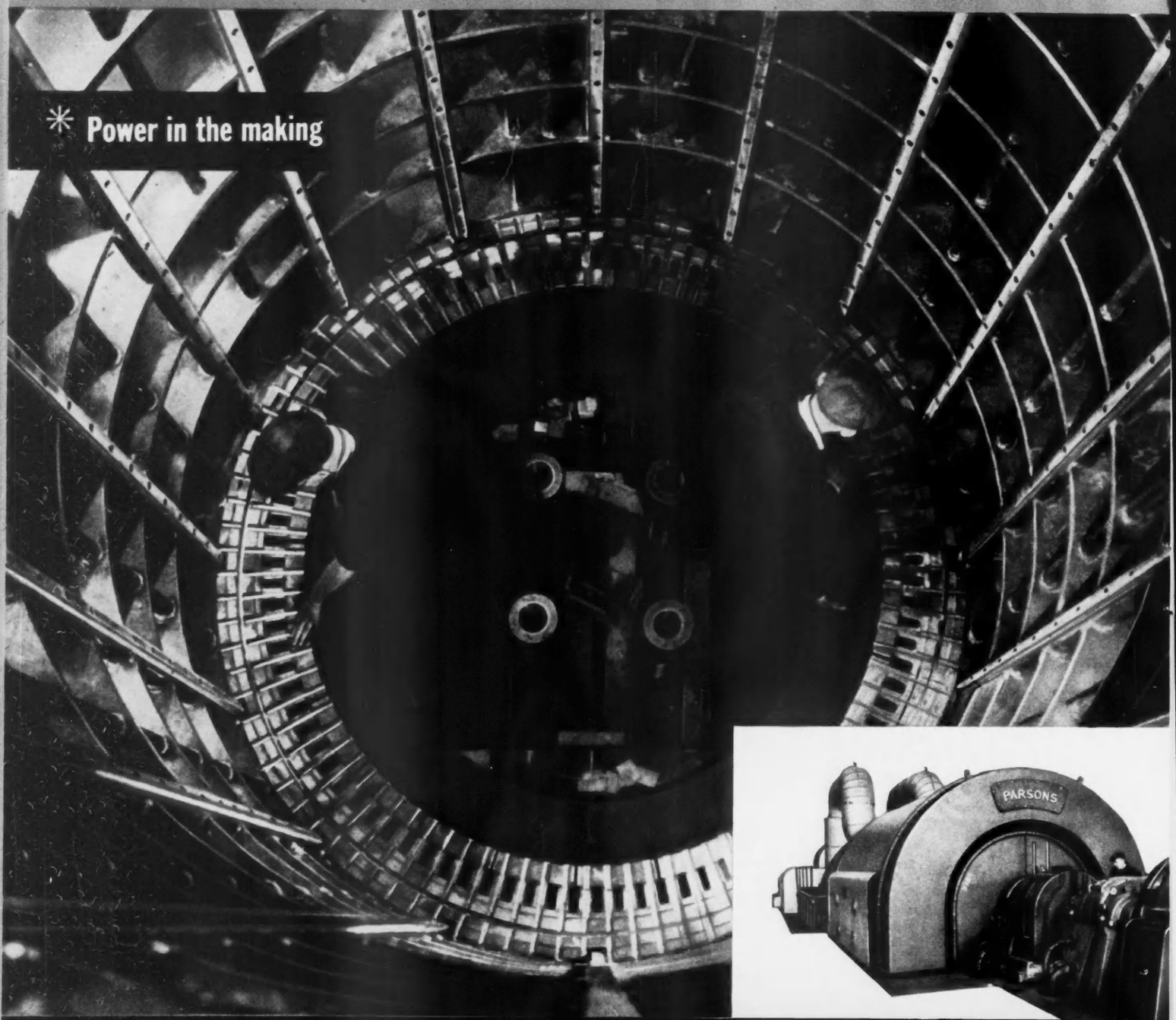


The main components of the *Twin-Air* Compressor are two screws which intermesh without metallic contact.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Write to Atlas Copco AB, Stockholm 1, Sweden, or contact your local company or agent. In Britain write to Atlas Copco (Great Britain) Ltd., Beresford Avenue, Wembley, Middlesex. P50R

Construction ...LARGE GENERATORS



✳ Power in the making

Fitting core end plate to the generator stator.

Inset: A typical completed 120 MW set.

✳

At PARSONS Heaton Works some of the largest electrical machines in the world are produced. At the present time turbo-generators of up to 550,000 kW are on order or under construction and many of the type illustrated here are being installed in C.E.G.B. power stations throughout the country.

TURBO-GENERATORS · POWER TRANSFORMERS · CONDENSING PLANT

PARSONS

C. A. PARSONS & CO. LTD.

HEATON WORKS · NEWCASTLE UPON TYNE 6

Hey Presto!

TODAY'S
open shelves can be
TOMORROW'S
fitted units

Here is a storage system which is so flexible that it can always be completely up-to-date.

From the carefully designed range of components, it is an easy matter to plan and erect an installation which will not only satisfy immediate storage needs but which can also be rapidly adapted to meet new requirements. Large articles or small, many or few, can be segregated as desired, and sections may be enlarged, reduced or subdivided at any time to conform to a changing pattern of purchases, production and consumption.

Components are made from best quality mild steel sheet and rolled steel sections, and are available in a range of standard sizes. Stove enamelled Olive Green or Scarborough Grey.

A typical three-bay assembly of trays, bins and shelves. The reverse side incorporates bins, cupboards and a ledge top. Bays may be varied as required, and joined to form a continuous run.

Full details of components and a selection of specimen assemblies are shown in List 1015. Please send for a copy. Mobile Type Shelving also available. Details on request.

HARVEY

ADJUSTABLE Steel Shelving

ANGLE POST TYPE

(Based on B.S.826 : 1955)

G. A. HARVEY & CO. (LONDON) LTD.

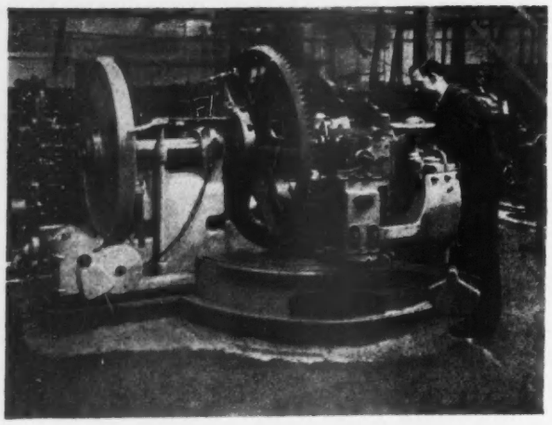
WOOLWICH RD., LONDON, S.E.7
Telephone: GREenwich 3232 (22 lines)

SE/11
C

BEVELS

UP TO 60 INCH DIAMETER

GOOD DELIVERIES AT COMPETITIVE PRICES

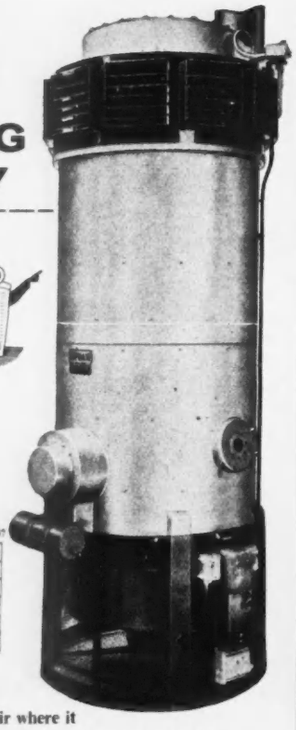


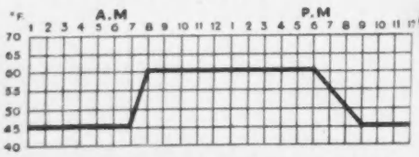
BARLOW & CHIDLAW
LIMITED
PENDLETON · MANCHESTER

ZEPHAIR

SPACE HEATING SAVES MONEY

ZEPHAIR automatic industrial air heaters are self contained. No boilers and accessories, ducting or special foundations are required and they can be easily installed in a few hours. Full heat output—at 84% efficiency—is available under thermostatic control almost instantly, when using light or 200 seconds oil, coal or gas, which are smokelessly burnt. Sized from 125,000 B.T.U.'s per hour upwards to suit the heating requirements.





Warmth at working-level—quickly

ZEPHAIR heating gently re-circulates warm air where it is most needed and ensures temperature uniformity. It can be used by itself or to supplement an existing system. There is no frost damage risk and close temperature control is possible.

ZEPHAIR LIMITED
1 Brandon Road, York Way, London, N.7.
Telephone: NORth 2245 8
50 Wellington Street, Glasgow, C.2.
Telephone: CENtral 5323/4
and at
BIRMINGHAM · BRISTOL · CARDIFF · LEEDS · LEICESTER · LIVERPOOL · NEWCASTLE

WPS—85

MIRRLEES

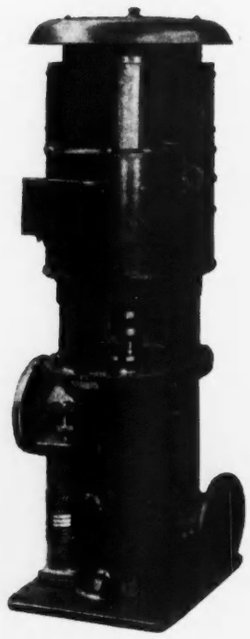
IMO

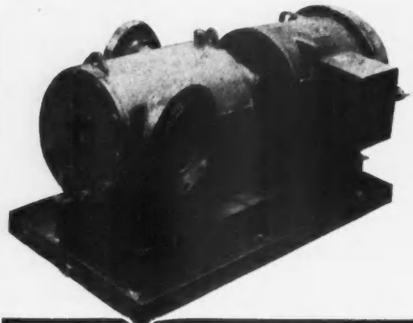
PUMPS
for every oil service

POSITIVE DISPLACEMENT · HIGH SPEED · SILENT OPERATION HIGH SUCTION LIFT WHERE NECESSARY · SELF PRIMING

Mirrlees IMO Pumps are of the rotary screw type, of unique design, for all capacities up to 600 tons per hour. They are available for a wide range of operating pressures, and may be run at motor synchronous speeds or directly driven by turbines at higher speeds.

HORIZONTAL
or
VERTICAL





MIRRLEES (ENGINEERS) LIMITED
Subsidiary of The Mirrlees Watson Company Ltd.
EARL HAIG ROAD, HILLINGTON, GLASGOW, SW2
London Office : 38 Grosvenor Gardens, SW1

FEL ELECTRIC LTD

THE CRACK DETECTION PEOPLE

41 SIDNEY STREET, SHEFFIELD, 1
PHONE: SHEFFIELD 27357/8

Flexello

CONSTANT QUALITY

CASTORS

Choose your castors from the largest range in Europe. Flexello will meet your special requirements individually, while our fabricating division designs and manufactures "special" castors for extra heavy and difficult applications.

illustrated are a small part of our vast range.

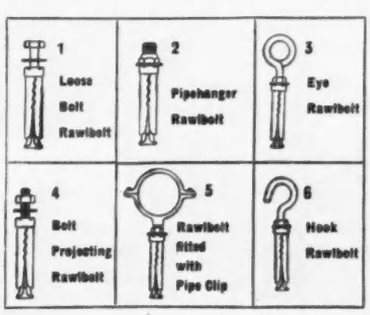
FACTORY EQUIPMENT EXHIBITION
EARLS COURT (APRIL 7-17) STAND H.14

Write for illustrated leaflet to Dept. **TE**

FLEXELLO CASTORS & WHEELS LTD., SLOUGH, BUCKS. Tel: SLOUGH 24121

You never need to improvise with Rawlbolts. There are types exactly right for every bolt-fixing job, No. 5, for example for the support of pipework, and No. 2 for use with Pipe-hangers and other gas fittings. Hook and Eye Rawlbolts (Nos. 3 and 6) have many uses, such as providing anchorage for guy ropes and cables, supporting suspended ceilings, etc. There's the Loose Bolt Rawlbolt (No. 1) inserted after the machine is slid into position, and the Bolt Projecting Type (No. 4), ideal for wall-fixings. Rawlbolts give you bolt-fixings of enormous strength in a fraction of the time taken by any other method.

6 HEADS are better than one!



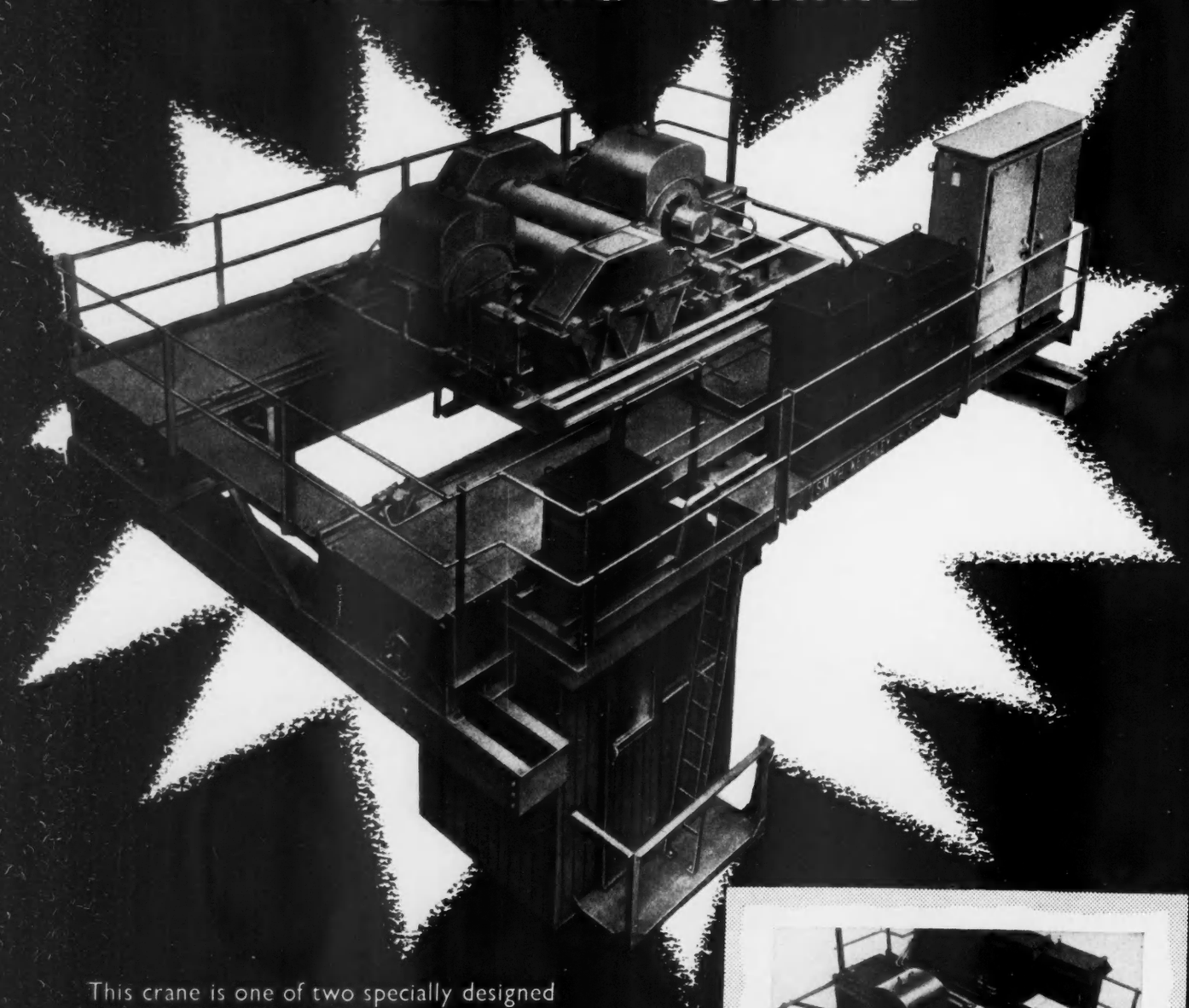
Every bolt-fixing job is far quicker with

RAWLBOLTS RAWLPLUG

THE RAWLPLUG CO. LIMITED
CROMWELL ROAD · LONDON · S.W.7

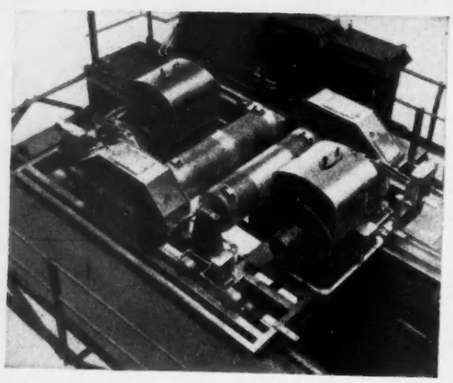
B580

OVERHEAD
GRABBING CRANE



This crane is one of two specially designed for heavy duty grabbing service in one of the new super power stations. The Cranes are operating in the open, and special attention has been given to weather-proofing and positioning of the units for easy access.

If you have a handling problem - call in **John Smith CRANES**



The Crab

The Crab is of the twin barrel type, having one barrel for "holding" and one for "opening" and "closing" the four rope Grab. All gear boxes are of steel fabricated welded construction.

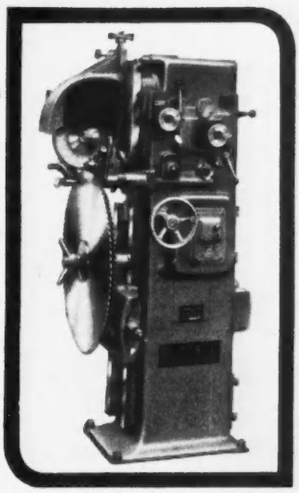
JOHN SMITH (KEIGHLEY) LTD.
P.O. BOX 21, THE CRANE WORKS, KEIGHLEY, YORKS.
Telephone: Keighley 2283 (4 lines) Telegrams: Cranes, Keighley

London Office: Buckingham House, 19 21 Palace St., (off Victoria St.), London S.W.1. Telephone: Tate Gallery 0377 8

Southern Counties Office: Brettenham House, Lancaster Place, Strand, London W.C.2. Telephone: Temple Bar 1515

RUSSELL

6" fully automatic "Hydrofeed." Many other types and sizes are available; full details on request.



Saw Sharpening Machine. Capacity 11" to 48" blades.

SR.552

Metal Sawing and Saw Sharpening Machines

Efficient Cutting. Russell "Hydrofeeds" have a hydraulic circuit of their own — specially designed for sawing — which offers distinct advantages over the conventional circuit.

Faster Cutting. Material handling and clamping have received special attention in designing.

Agencies established in Australia, Canada, India, New Zealand, South Africa, U.S.A., Brazil, Argentine, and all West European countries.

Backed by over forty years' specialised experience.

S. RUSSELL & SONS LIMITED, Leicester, England

RESISTANCE STRAIN GAUGES

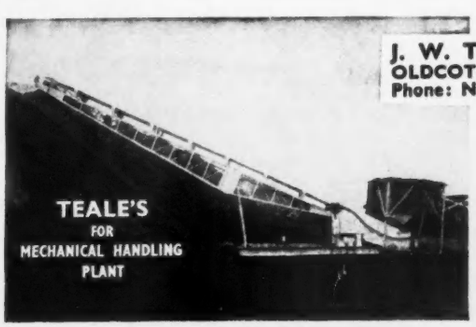
By J. YARNELL, B.Sc., A.Inst.P.

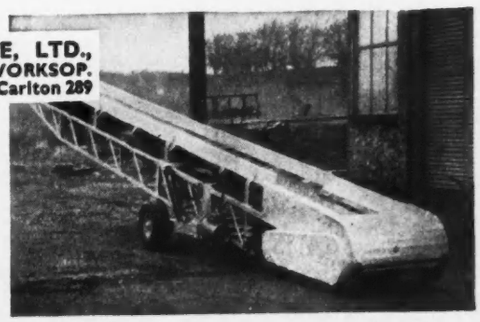
Price 12s. 6d. *(Postage 6d.)*

This book deals with the construction and application of resistance strain gauges and with the most commonly used circuits and apparatus. The strain gauge rosette, which is finding ever wider application, is treated extensively, being introduced by a short exposition of the theory of stress and strain in a surface.

Order your copy through your Bookseller or direct from:—

ELECTRONIC ENGINEERING, 28, Essex Street, Strand, London, W.C.2.





J. W. TEALE, LTD.,
OLDCOTES, WORKSOP.
Phone: North Carlton 289

HAMMERED OR HYDRAULIC PRESSED

FORGINGS

IN STEEL BLACK OR MACHINED TO 24 TONS

INCE FORGE CO. WIGAN
PARKS FORGE LTD
PROPRIETORS

RE

PROTOTYPES

EXTREMELY ACCURATE PLATE CAMS

ELECTRONICALLY CONTROLLED CAM MILLING MACHINES

SPECIAL PURPOSE MACHINES

Research Engineers Ltd.,
CANONBURY, N.1
CAN 4244/5/6
Telegrams: "Wilmaket, Nordo, London"

McNEIL

manhole doors for air-receivers, boilers, etc.

HEAVY STEEL PRESSINGS

FOUNDRY LADLES

FABRICATED STEELWORK

WELDED CENTRAL HEATING BOILERS

CHARLES McNEIL LIMITED
KINNING PARK HYDRAULIC FORGE
570 SCOTLAND STREET, GLASGOW, S.1.
Grams: "McNeil, Glasgow" Phone: South 1131

CORONA

Ettco

BRITISH MADE

TAPPING ATTACHMENTS

Will fit any standard drilling machine with morse taper drive

Made in 3 sizes
Tapping capacity $\frac{1}{16}$" to $\frac{3}{8}$" dia.

Automatic reverse. Friction clutch drive
Tap idles in forward direction

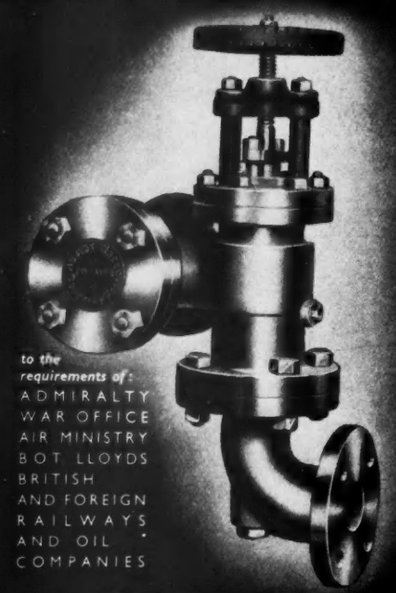
Tap breakage practically eliminated

Telegrams 'Corona' Leicester

FREDK. POLLARD & CO. LTD.
CORONA WORKS, LEICESTER
ENGLAND

Telephone Leicester 67534 (5 lines)

"HYSON" VALVES and BOILER MOUNTINGS

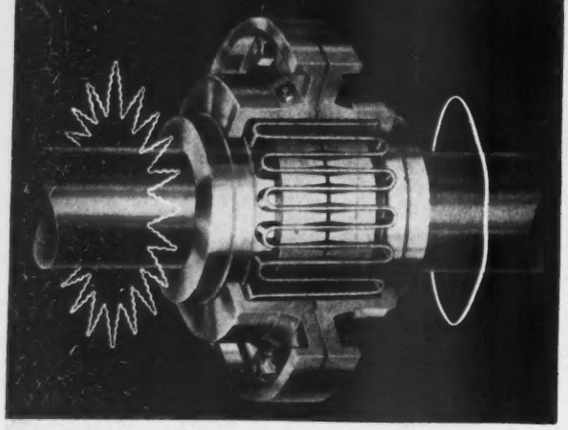


to the requirements of:
ADMIRALTY
WAR OFFICE
AIR MINISTRY
BOT LLOYDS
BRITISH
AND FOREIGN
RAILWAYS
AND OIL
COMPANIES

Over a Century of Experience

SMITH BROS. & CO. (HYSON) LTD.
HYSON GREEN VALVE WORKS
NOTTINGHAM, ENGLAND
Telegrams "HYSON" Telephone NOTTINGHAM 77234

The most efficient couplings obtainable



BIBBY

Resilient

COUPLINGS

For nearly forty years Bibby Resilient Couplings have enjoyed an unexcelled reputation for efficiency and reliability and numerous Couplings supplied over thirty years ago are still giving trouble-free service.

The outstanding resilience of Bibby Couplings dampens shocks and vibrations, ensures smooth running of plant, eliminates breakdowns. Standard Couplings up to $7\frac{1}{2}$" bore can be supplied from stock.

We invite you to write for our illustrated brochure.

THE WELLMAN BIBBY COMPANY LIMITED
PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1

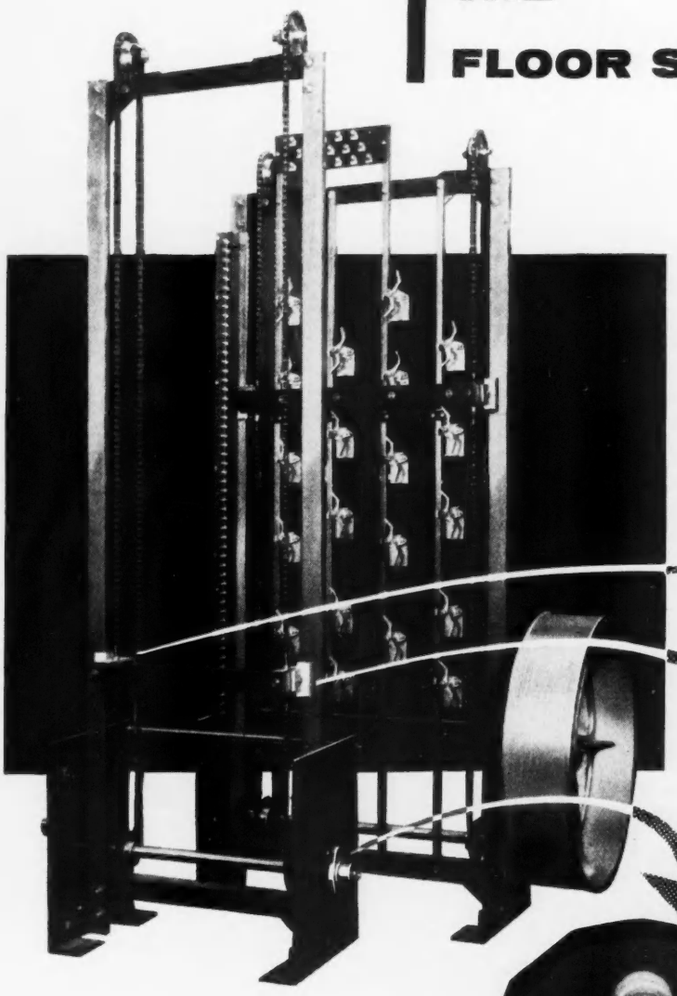
ALZEN BEARINGS PLAIN & SLIDE ARE INCORPORATED

ALZEN 305

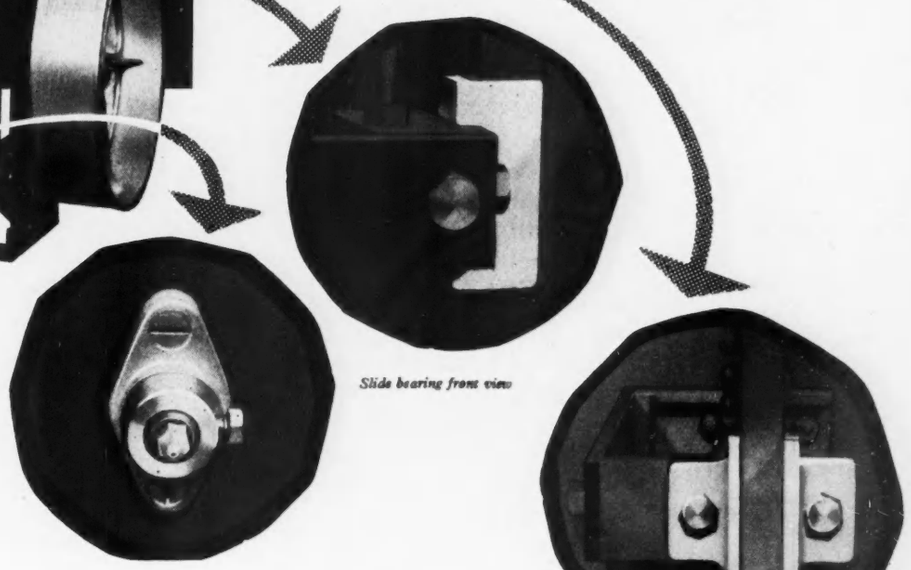
Regd. Trade Mark B 752748

IN THE FLOOR SELECTING MECHANISM OF THIS INDUSTRIAL LIFT

Photographed by courtesy Aldous & Campbell Ltd.



ALZEN 305 REDUCES COST HALVES WEIGHT & LENGTHENS BEARING LIFE



Slide bearing front view

Plain bearing

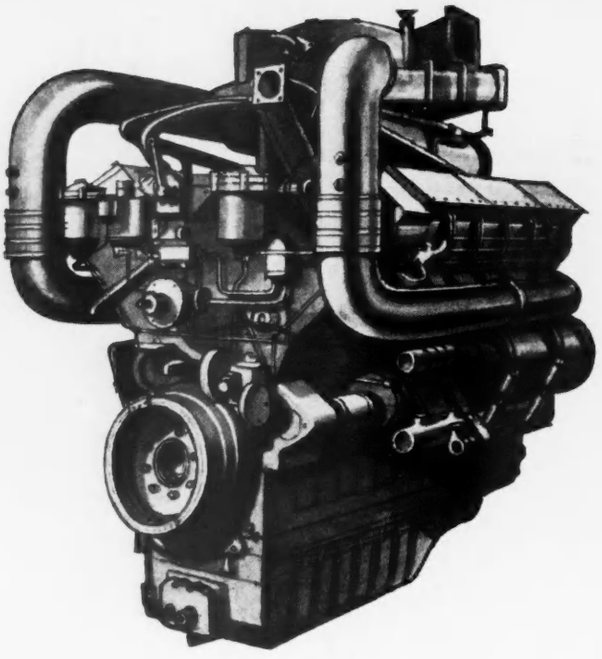
Slide bearing side view

ENGINEERING EXHIBITION OLYMPIA APRIL 16-30th STAND NO. **4** ROW N GROUND FLOOR NATIONAL HALL

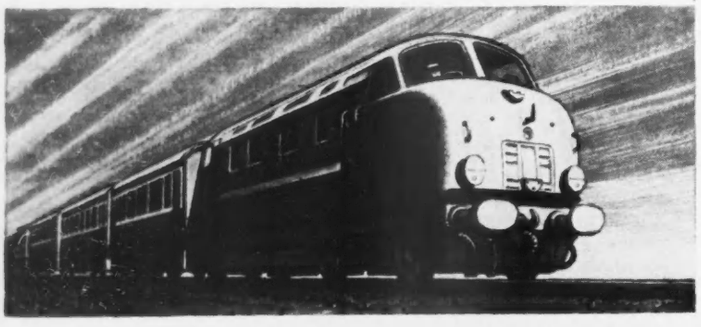
Alzen 305 White Bronze Bearing Alloy Patent No. 725818 is eminently suitable for most Heavy Duty Bearing Applications and is supplied in the following forms :—Ingot, chill cast bars, cored and solid, in approx. 2 ft. lengths, sand castings, shell moulded castings, gravity die castings, pressure die castings, fully machined bushes and bearings. Also Alzen Extruded material specified as Alzen 305K. Bar—solid or tube in random lengths of 10/12 feet. HILL ALZEN (SALES) LTD. P.O. Box 22, Stringes Lane, Willenhall, Staffs. Telephone : Willenhall 227 (5 lines). Telegrams : Hill Alzen 227 Willenhall. May we send technical literature and samples for testing?

WhiteAd 3947

MAYBACH POWER MADE IN BRITAIN



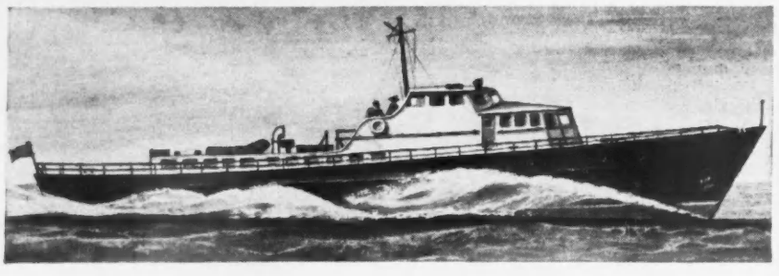
Typical of the MD range of engines is this Type 650 12 cylinder supercharged model with cylinders arranged in 'V' formation.



Railway Traction 220-2,000 B.H.P.

Industrial Plant 220-1,750 B.H.P.

Marine 220-3,000 B.H.P.



Armstrong Siddeley have the exclusive manufacturing and selling licence in the United Kingdom for the world-famous Maybach MD range of In-line and 'V' form diesel engines. These diesels range from 4 cylinder engines of 220 hp to 16 cylinder engines of 3,000 hp. They have an outstanding record of performance and reliability over millions of miles on railways throughout the world, and are widely used for marine propulsion and industrial power generation of all kinds.

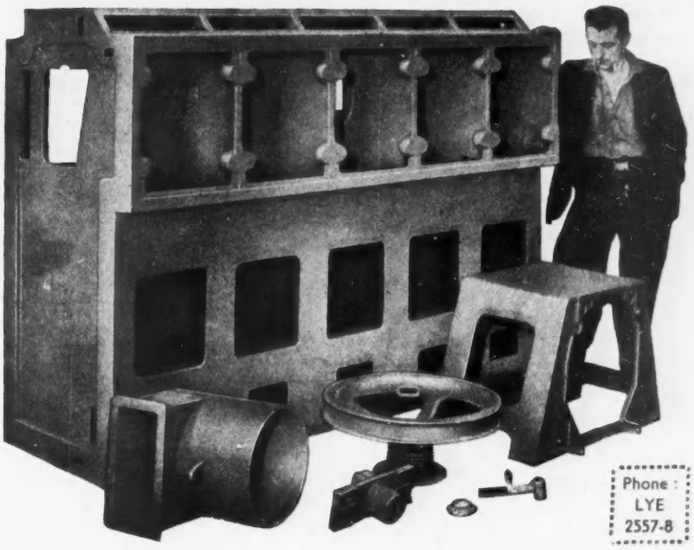
ARMSTRONG SIDDELEY
Maybach
DIESEL ENGINES

ARMSTRONG SIDDELEY MOTORS
Coventry, England
ENGINE BUILDERS TO THE WORLD

MEMBER OF THE HAWKER SIDDELEY GROUP

GREY IRON CASTINGS *up to* 25 TONS

In the production of Grey Iron Castings we have concentrated on these four vital points: accurate moulding to specification, unvarying quality throughout the run; clear finish and excellent machining surfaces; competitive prices. We shall be pleased to advise you on any particular castings problem. Our long experience is at your service.

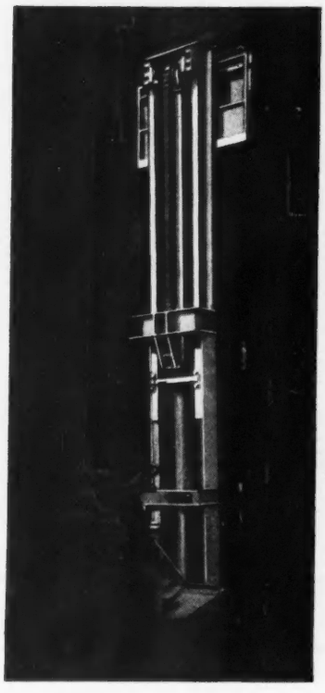


Phone: LYE 2557-8

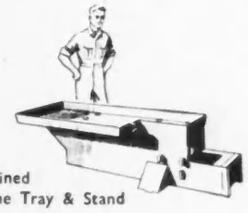
S. MOLE & SONS (GREEN LANE FOUNDRY) LTD. BOTT LANE · LYE · STOURBRIDGE · WORCS.

HIGH GRADE

FABRICATION WORK

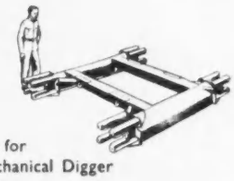


Mast Assembly for Fork Lift Truck

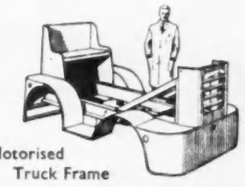


Combined Lathe Tray & Stand

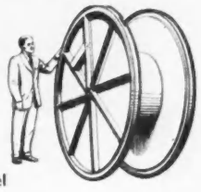
Traller Chassis



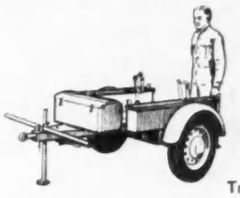
Chassis for Mechanical Digger



Motorised Truck Frame



Cable Reel



Trailer

For technical service or advice
TELEPHONE SEDGLEY 3066

The MATERIAL HANDLING DIVISION of FISHER & LUDLOW ANNOUNCE greatly increased facilities for quality Fabrication work at their new factory at COSELEY, STAFFS.

Exceptional technical facilities enable us to offer keen prices for repeat fabrication work of all kinds to any production schedule.

FISHER & LUDLOW LTD · MATERIAL HANDLING DIVISION
BORDESLEY WORKS · BIRMINGHAM - 12

JUST PUBLISHED —

"A complete library in two volumes.."

KEMPE'S

Engineers Year-Book

Edited under the direction of the Editor of "The Engineer"

1959

(64th Edition)

82/6

(plus postage 2/6)

★ **3,000 pages covering modern theory and practice in all branches of engineering. No other single publication devoted to engineering covers a comparable range of subjects so concisely.**

•

ORDER YOUR COPY NOW

Obtainable direct from the publishers or through your local booksellers

Send for complete prospectus to:-

Kempe's Engineers Year-Book

28 Essex Street, Strand, London, W.C.2

Telephone: Central 6565

Hewittic Rectifiers FOR STEELWORKS

The illustration shows two 900 kW Hewittic Rectifiers providing an output of 3600 amps for operating rolling mill auxiliaries in a Scottish steelworks.

There are over 1,500,000 kW of Hewittic Rectifiers in world wide service in capacities up to 30,000 kW.

HACKBRIDGE AND HEWITTIC ELECTRIC COMPANY LTD

HERSHAM • WALTON-ON-THAMES • SURREY

Telephone: Walton-on-Thames 760 (8 lines) *Telegrams and Cables "Electric" Walton-on-Thames*

Send for Publications R190 R222

OVERSEAS REPRESENTATIVES

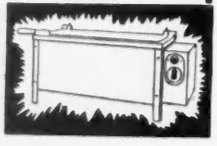
ARGENTINA : H. A. Roberts & Cia., S.R.L., Buenos Aires. AUSTRALIA : Hackbridge and Hewittic Electric Co. Ltd., 171, Fitzroy Street, St. Kilda, Victoria ; N.S.W. ; Queensland ; W. Australia ; Elder, Smith & Co. Ltd.; South Australia ; Parsons & Robertson Ltd.; Tasmania : H. M. Bamford & Sons (Pty.) Ltd., Hobart. BELGIUM & LUXEMBOURG : M. Dorfman, 5, Avenue des Phalenes, Brussels. BRAZIL : Oscar G. Mors, Sao Paulo. BURMA : Neonlite Manufacturing & Trading Co. Ltd., Rangoon. CANADA : Hackbridge and Hewittic Electric Co. of Canada Ltd., Montreal ; The Northern Electric Co. Ltd., Montreal, etc. CEYLON : Envee Ess Ltd., Colombo. CHILE : Sociedad Importadora del Pacifico Ltda., Santiago. EAST AFRICA : G. A. Neumann, Ltd., Nairobi. EGYPT : Giacomo Cohenca Fils, S.A.E., Cairo. FINLAND : Sähkö-ja Koneliike O.Y. Hermes, Helsinki. GHANA, NIGERIA & SIERRA LEONE : Glyndova Ltd. NETHERLANDS : J. Kater E.I., Ouderkerk a.d. Amstel, Amsteldijk Noord 103c. INDIA : Steam & Mining Equipment (India) Private Ltd., Calcutta ; Easun Engineering Co. Ltd., Madras, 1. IRAQ : J. P. Bahoshy Bros., Baghdad. MALAYA, SINGAPORE & BORNEO : Harper, Gilfillan & Co. Ltd., Kuala Lumpur. NEW ZEALAND : Richardson, McCabe & Co. Ltd., Wellington, etc. SOUTH AFRICA : Arthur Trevor Williams (Pty.) Ltd., Salisbury. THAILAND : Vichien Phanich Co. Ltd., Bangkok. TRINIDAD & TOBAGO : Thomas Peake & Co., Port of Spain. TURKEY : Dr. H. Salim Oker, Ankara. U.S.A.: Hackbridge and Hewittic Electric Co. Ltd., P.O. Box 234, Pittsburgh 30, Pennsylvania. VENEZUELA : Oficina de Ingenieria Sociedad Anonima, Caracas. R31

PROTECTION

against **ROUGH HANDLING**

"GLOSCOAT" is a plastic protective packaging material for the protection of tools, machine parts and simple assemblies. It is applied by dipping and removed by stripping. It protects against corrosion, rust and rough handling and can reduce packaging time by at least 60 per cent man-hours.

Type L. Tank.



GLOSCOAT

Manufactured by Glostics Ltd., Gloucester, England.

***STRIPPABLE HOT DIP* PROTECTIVE COATING**

SOLE DISTRIBUTORS FOR THE U.K.

Write Dept. BC/4 for full technical details.

J. M. STEEL & CO. LTD.

36/38 Kingsway, London, W.C.2. Tel.: Hol. 2532/5

Branch Offices :

51, South King St., Manchester 2 Tel.: Deansgate 6077/9

45, Newhall St., Birmingham 3. Tel.: Central 6342/3

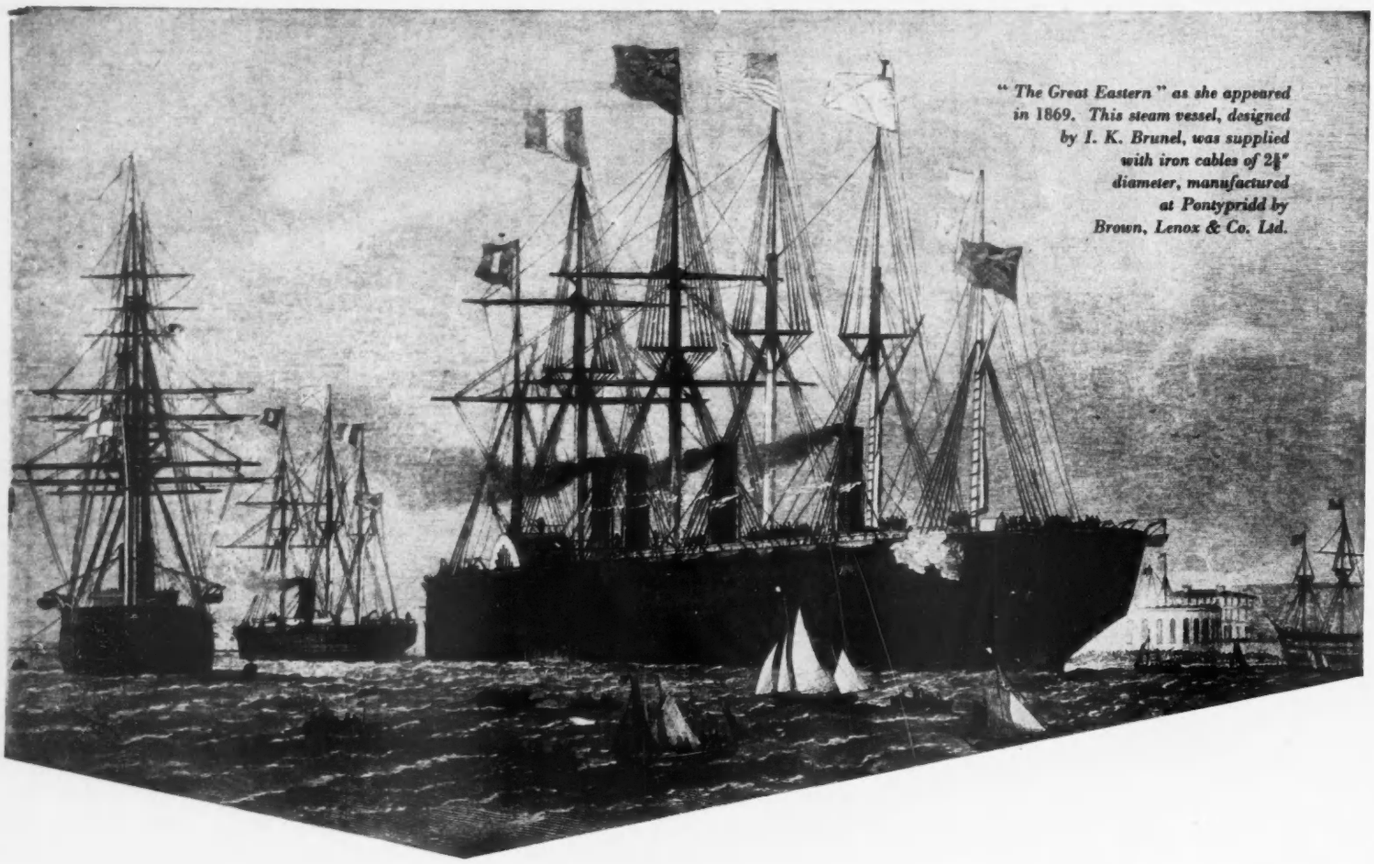
MILLS grooved pins

NO REAMING
NO TAPPING
DRILL AND DRIVE HOME!

12 different types
to suit all needs

EXORS. OF JAMES MILLS LTD.

BREDBURY STEEL WORKS
WOODLEY. NR. STOCKPORT
Telephone: WOODLEY 2231.(10 lines) Telegrams: "MILLS" PHONE WOODLEY



" The Great Eastern " as she appeared in 1869. This steam vessel, designed by I. K. Brunel, was supplied with iron cables of 2¼" diameter, manufactured at Pontypridd by Brown, Lenox & Co. Ltd.

From Napoleon to Elizabeth II . . .

The founder of this Company *invented* and manufactured the first chain cable ever to be used for the mooring of ships ; this was in 1806.

From 1808 until 1916 the Company unbrokenly, year by year, was awarded the contract for the British Admiralty chain cable requirements.

Today, Brown, Lenox & Co. Ltd. is known all over the World as one of the leading firms specialising in the design of moorings—and in the manufacture of the components of which a mooring is made up.

The Company operates one of the very latest types of automatic machines for the production of ***high tensile electric flash butt welded steel chain cable.*** *Chain cable is made* ***in sizes up to those suitable for mooring the largest vessels afloat.***

The following publications are available:

- **MOORINGS AND BUOYS** (32 Pages)
- **BLeCO MOORING AND SHIPS CHAIN CABLE** (8 Pages)
- **BLāCO HIGH TENSILE STEEL CHAIN CABLE** (Leaflet)
- **SHIPS CHAINS, ANCHORS & ANCILLARY GEAR** (16 Pages)

Copies of any, or all, of these publications will be sent free of charge, and postage paid.

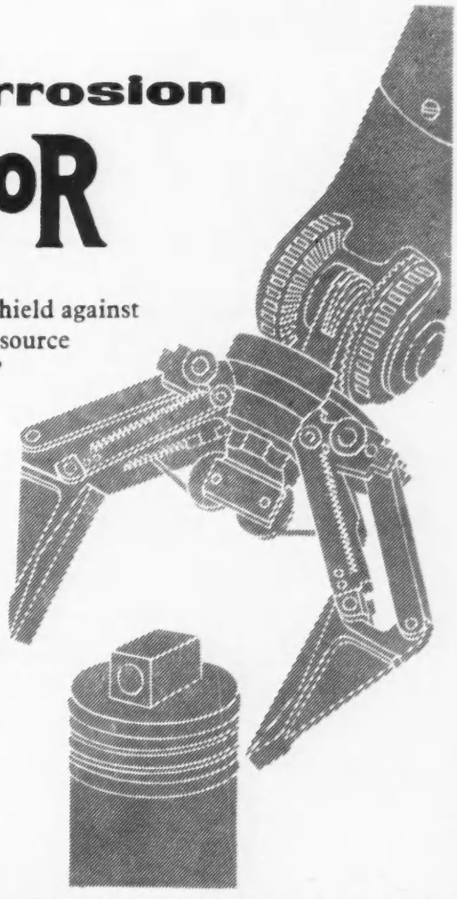
Brown Lenox

Illustration by courtesy of the Trustees of the National Maritime Museum.

An announcement by the Marine Division of

BROWN, LENOX & COMPANY LIMITED
Associated Company: Brown, Lenox & Co. (London) Ltd., Millwall, E.14
PONTYPRIDD GLAMORGAN

So long as there's corrosion there'll always be APEXIOR REGISTERED



In all the changes of over fifty years, APEXIOR has been a sure shield against the costly ravages of corrosion. So it will remain. Whether the source of power be coal, oil or nuclear reaction, "APEXIOR NUMBER 1" will still ensure the most reliable protection for the internal surfaces of all steam-raising plant—wherever wet-heat temperatures between 170°—1000°F are encountered. "APEXIOR NUMBER 3" is equally trustworthy in cold-wet conditions up to 125°F and for the prevention of corrosion by galvanic action on the stern parts of ships.
Send for your copy of the Apexior Manual today.

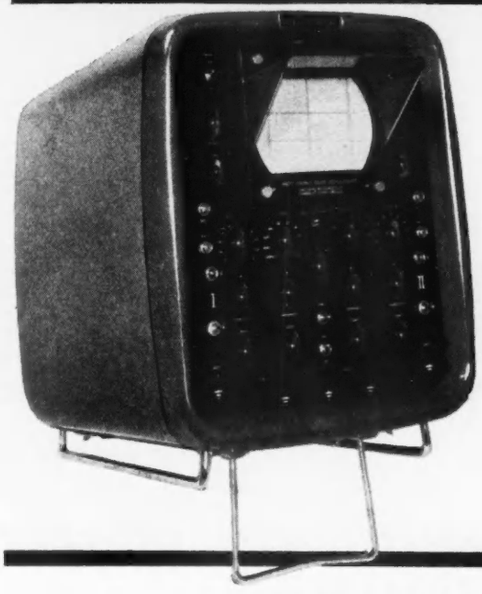
DAMPNEY'S APEXIOR REGISTERED **SUREST SAFEGUARD AGAINST CORROSION**

"Apexior" is being used at Stations throughout the U.K. Atomic Energy Authority

BRITISH PAINTS LIMITED *'Apexior' Division*
PORTLAND ROAD, NEWCASTLE UPON TYNE, 2
Crewe House, Curzon Street, London W.1 · 31, Wapping, Liverpool
OUR WORLD-WIDE SERVICE IS AT YOUR DISPOSAL FOR THE ASKING
SYDNEY · ADELAIDE · DURBAN · CAPE TOWN · CALCUTTA · TRINIDAD · NEW YORK

A new tool for research and industry

minirack
INSTRUMENT TYPE M977



SPECIFICATION

CATHODE-RAY TUBE. '20th Century' D6B, 6-inch diameter, flat-faced and having two separate guns with independent controls. Sensitivity at 2Kv. E.H.T. supply: Y=24 volts/cm. (61 volts/inch). X=25 volts/cm. (63 volts/inch).

Y AMPLIFIERS. Input Impedance: 2·2 megohms shunted by 15 pF approx. Input R.C. coupling time constant: 0·22 seconds. Input Attenuator: 10 : 1 frequency compensated. Amplification: 26 to 800 continuously variable. Signal Calibration: ±2 volts in 0·1 volt divisions. Calibration Accuracy: ±5%. Frequency Response: D.C. to 100 Kcps 10% down. D.C. to 150 Kcps 30% down. Output Swing: 400 volts at a mean level of 150 volts above earth. Linearity of output: ±2%.

X AMPLIFIERS. Input Impedance: 1 megohm shunted by 50 pF approx. Amplification: 11 to 210 continuously variable. Frequency Response: D.C. to 150 Kcps 10% down. D.C. to 300 Kcps 30% down. Output Swing: 440 volts at a mean level of 150 volts above earth. Linearity of output: ±2%.

TIME-BASE. Calibration Accuracy: ±25% on range 100 millisec—10 seconds. ±10% on range 0·3–30 millisec. Output: Positive going sweep ±10 volts about earth. Minimum internal sync. amplitude; 1 cm. Minimum external sync. amplitude; 1 volt peak-to-peak. The sync. amplifier is self-limiting.
200–250 volts 50–60 c.p.s.

The new 'Southern Instruments' M977 is a completely self-contained Double-Beam Oscilloscope of advanced design at a highly competitive price.

With its facilities for direct comparison of wave forms, it is invaluable for the visual display of many phenomena in engineering and industry.

It is an ideal tool to form a nucleus for a wide range of auxiliary equipment, such as pre-amplifiers, transducers, and recording cameras.

SOUTHERN INSTRUMENTS

AN ADVERTISEMENT OF THE OSCILLOGRAPH GROUP OF SOUTHERN INSTRUMENTS LIMITED CAMBERLEY SURREY. TELEPHONE: CAMBERLEY 3401

PRIEST

for forge and heat treatment furnaces

F119

PRIEST FURNACES LTD · LONGLANDS · MIDDLESBROUGH

FOR MANY PRACTICAL PURPOSES

engineers use

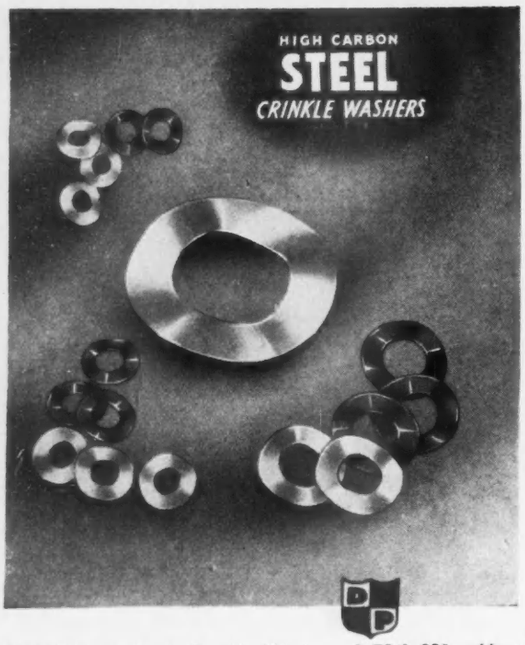
'Plasticine'

Reg'd Trade Mark

'Plasticine' has many important uses in engineering. Uses as wide apart as making experimental models and retrieving small parts which have fallen into a machine. 'Plasticine' is ductile, antiseptic, watertight, stable in character, and it adheres quite easily to metal. It is ideal for sealing and for holding irregular objects in position. Every engineer should have 'Plasticine' at hand. For more detailed information on its uses write to:—

HARBUTT'S PLASTICINE LTD. (Dept. E), BATHAMPTON, BATH, SOMERSET

Harbutt's were the inventors and remain the sole makers of 'Plasticine'

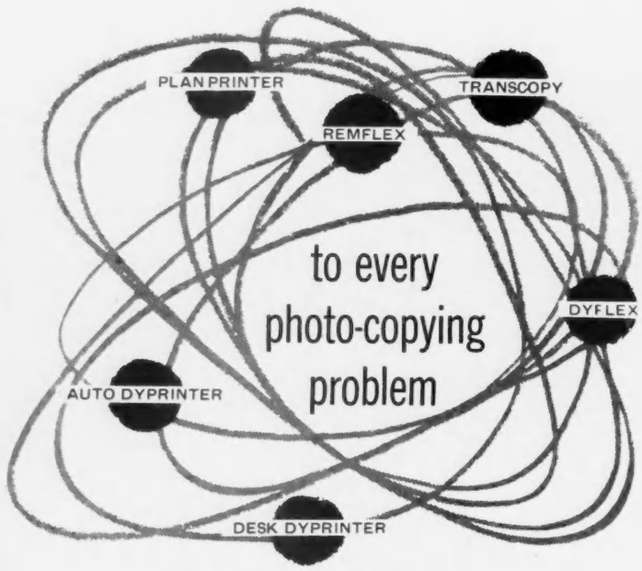


High Carbon Steel Crinkle Washers 0·75/0·85". Heat Treated and finished Blued or Plated. Its design prevents damage to polished or Plated surfaces and so eliminates a basis for corrosion. Its counter-part, made from Beryllium Copper, is extensively used in the Electrical and Electronic Industries.

DAVID POWIS & SONS LTD.

FORWARD WORKS · SPARKBROOK · BIRMINGHAM 11 · PHONE: VIC 1264-8

Only Remington Rand have the **right** answer



How do you decide which process or which machine will suit you best?

The answer is easy.
You consult Remington Rand because they provide them all and will therefore give a completely unbiased opinion.

It will cost you nothing, commit you to nothing to call in our experts — or if you prefer to examine the whole subject before consulting us, write or phone for a free copy of

'The Business Man's Guide to Photo-Copying'

PART OF THE PROOF THAT

Remington Rand

EQUIPS BUSINESS FOR PROSPERITY

Remington Rand Ltd · 1-19 New Oxford St · London WC1 CHA 8888

Branches in all principal cities

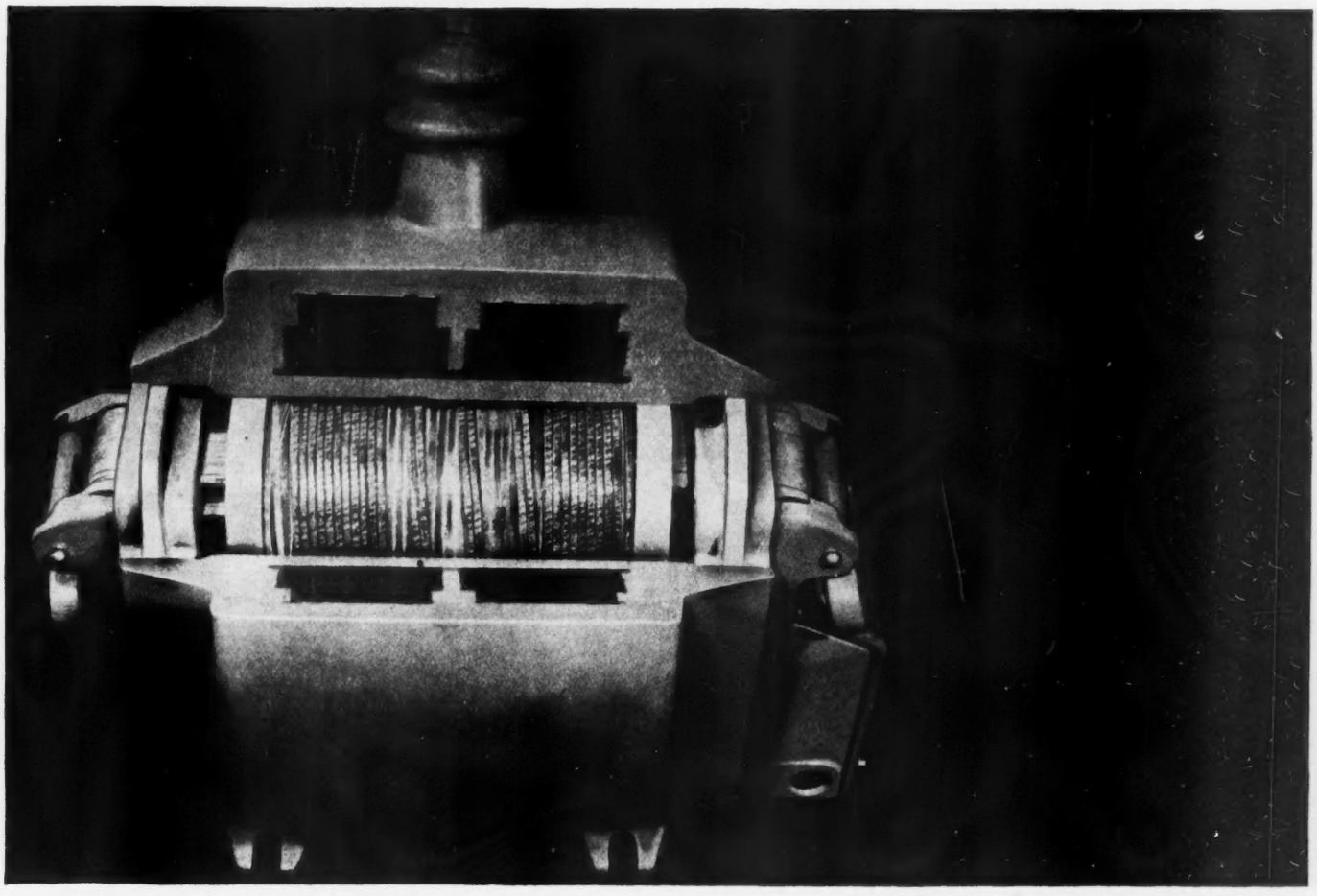
"Araldite" is a registered trade name

The World uses Araldite

C I B A

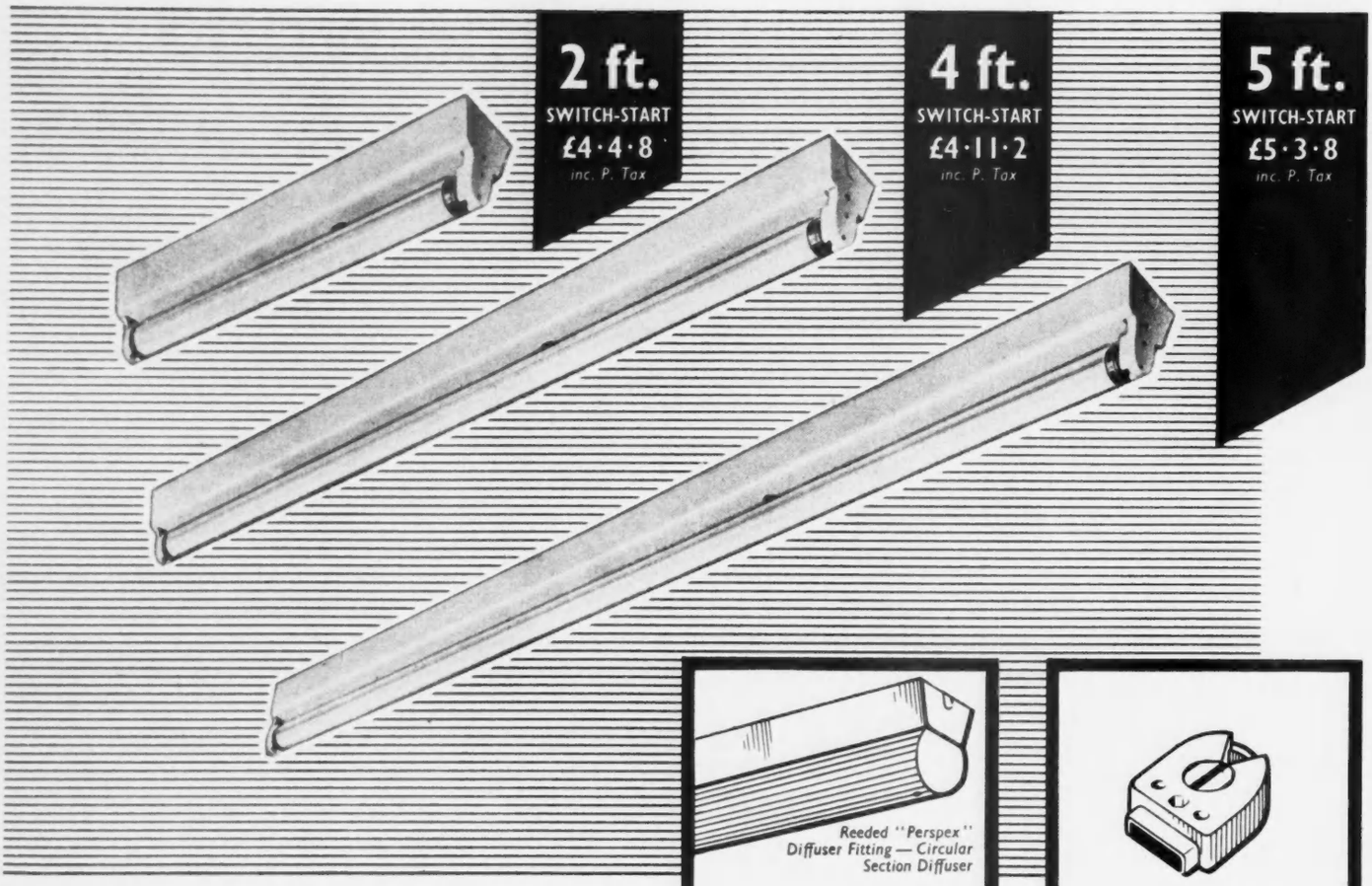
Germany

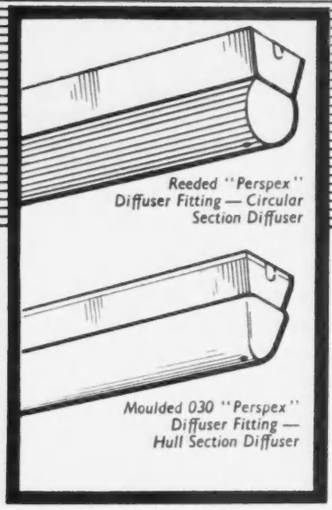
Dry voltage transformer Type KSZ, Class 05; 20 kV, 90 VA high voltage coil impregnated and cast in "Araldite" Resin.
Manufacturer: A.E.G. Allgemeine Elektricitäts-Gesellschaft Berlin-Reinickendorf.



CIBA (A.R.L.) LTD
Duxford, Cambridge. Telephone: Sawston 2121

Araldite Casting Resins
Araldite Coating Resins
Araldite Laminating Resins
Araldite Adhesives




Reeded "Perspex" Diffuser Fitting — Circular Section Diffuser
Moulded 030 "Perspex" Diffuser Fitting — Hull Section Diffuser

Philips exclusive spring-loaded rotor type Bi-pin lampholder — simplifies lamp installation and removal

NEW

low cost lighting!

Philips present another important new lighting development! Available in 2ft., 4 ft., and 5 ft. sizes, each of these new TME units consists of a specially designed and robust batten fitting, complete with a Philips double-coated Warm White de Luxe Tube and with all electrical components entirely enclosed. In addition, two types of perspex diffusers are available: reeded or moulded. And look at the other exclusive features listed on right.

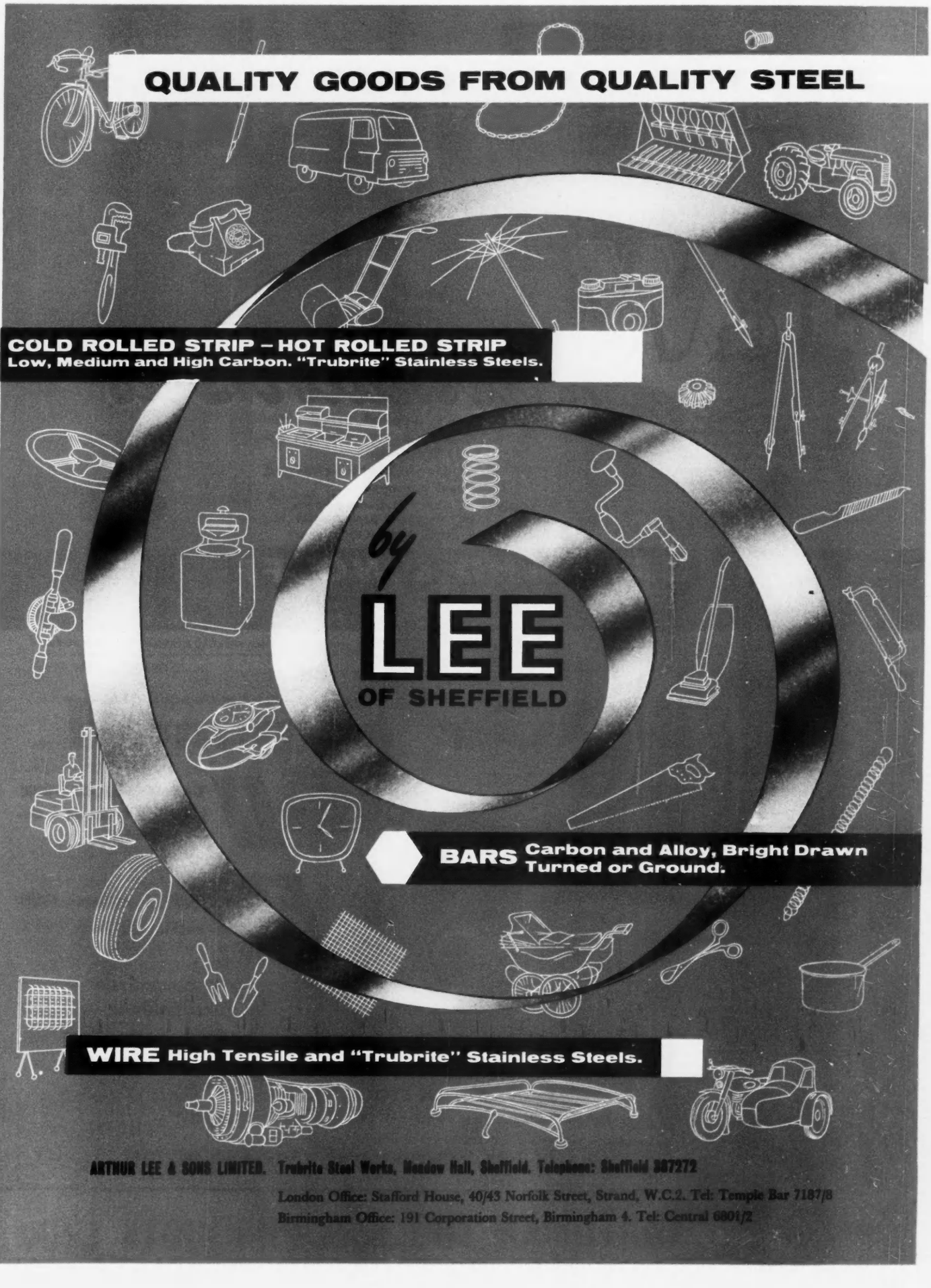
- *Simpler one-man fixing—and the lamp can be inserted with one hand only.*
- *Unique Philips spring-loaded rotor type Bi-pin lampholders.*
- *Supplied complete with Philips double-coated Warm White de Luxe tubes. (Bi-pin Capped.)*
- *Incorporates the new Philips Polyester-filled ballast —smaller, lighter in weight, silent.*

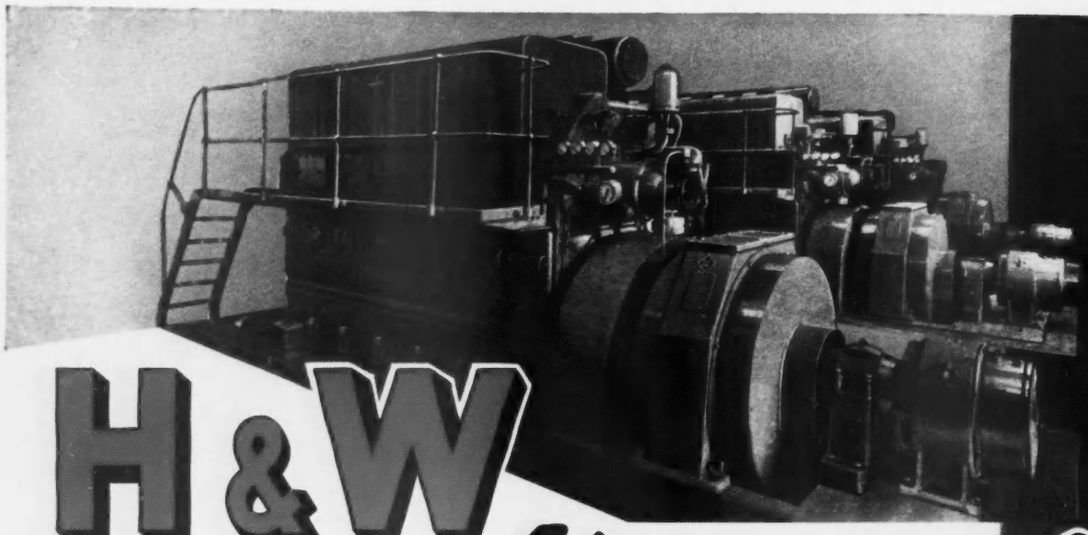
PHILIPS series TME Bi-pin units

PHILIPS

PHILIPS ELECTRICAL LTD. (LIGHTING DIVISION) · Century House · Shaftesbury Avenue · London · W.C.2

(LD3118B)


QUALITY GOODS FROM QUALITY STEEL
COLD ROLLED STRIP – HOT ROLLED STRIP
Low, Medium and High Carbon. "Trubrite" Stainless Steels.
by
LEE
OF SHEFFIELD
BARS Carbon and Alloy, Bright Drawn Turned or Ground.
WIRE High Tensile and "Trubrite" Stainless Steels.
ARTHUR LEE & SONS LIMITED. Trubrite Steel Works, Meadow Hall, Sheffield. Telephone: Sheffield 887272
London Office: Stafford House, 40/43 Norfolk Street, Strand, W.C.2. Tel: Temple Bar 7187/8
Birmingham Office: 191 Corporation Street, Birmingham 4. Tel: Central 6801/2



Three H & W dual-fuel engines with H & W alternators. Each alternator set develops 330 kW at 428 r.p.m. and operates on sludge gas

H & W Alternator Sets

Alternators and engines are of H & W design and manufacture thus ensuring our undivided responsibility for the complete power set. We also supply the necessary control equipment.

H & W alternators supplied in all sizes from 60 to 5,000 kVA and voltages up to 11 kV. with H & W 2- or 4-stroke turbo-charged Diesel engines

("In line" and "V" type 4-st. Diesel engines can be supplied naturally aspirated or turbo-charged with or without air coolers)

HARLAND & WOLFF LIMITED

Enquiries: Queen's Island, Belfast — London Office: 9, Whitehall, S.W.1

BELFAST GLASGOW LONDON LIVERPOOL SOUTHAMPTON

DOWPACs a punch!

1 The DOWPAC LIQUID SPRING gives 3,900 lbs. at a deflection of 1".

2 ONE DOWPAC replaces EIGHT conventional springs.

Overall dimensions 4½"x1⅝" dia. provides concentrated power and occupies but a fraction of the space taken up by conventional springs. The power of the DOWPAC is the answer to all stripping or spring problems.

DELIVERY:—EX STOCK. Other sizes in course of production. (Patent applied for.)

*For further details, write or telephone:—***SOLE DISTRIBUTORS**

A DOWTY PRODUCT

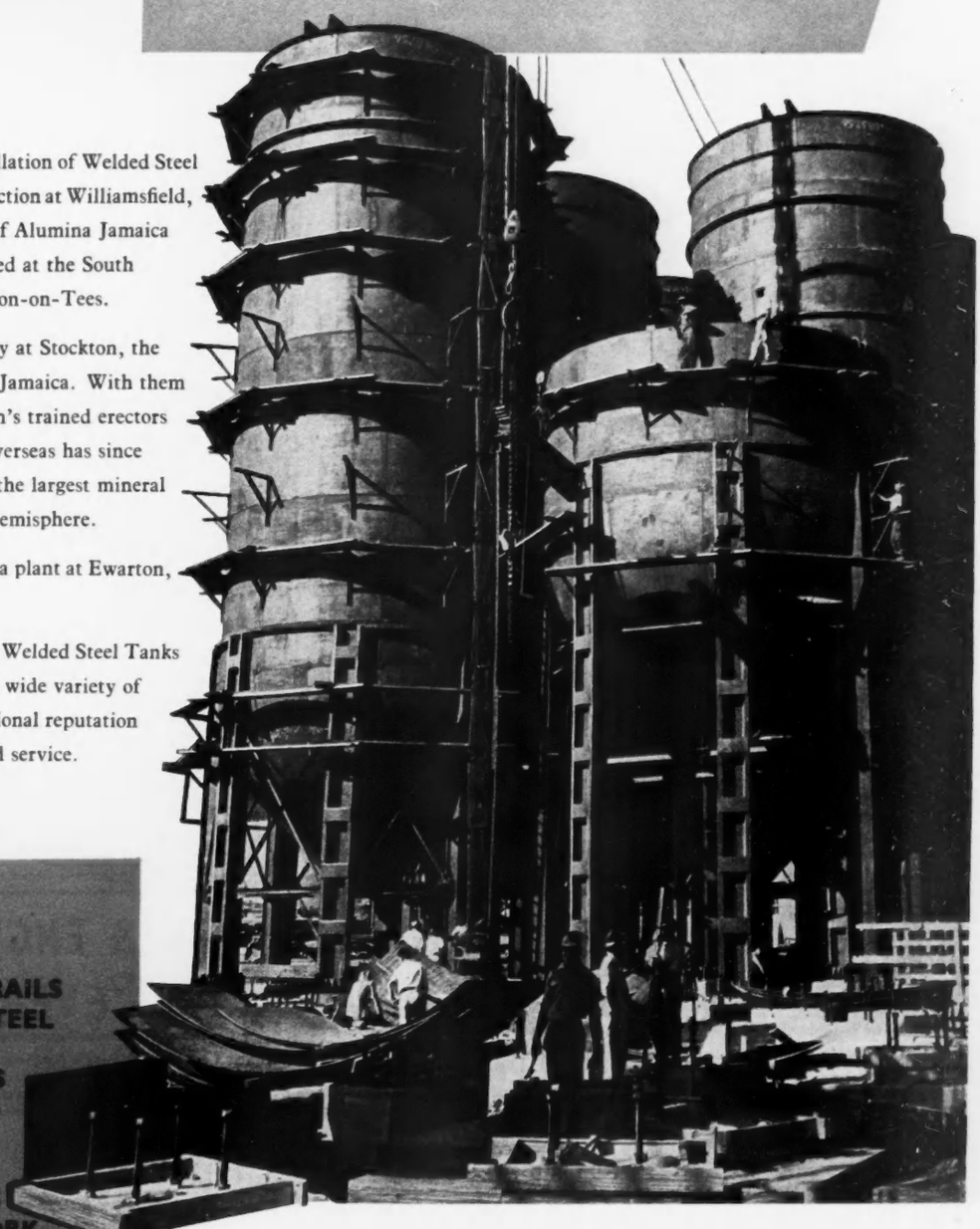
REDMAN TOOLS & PRODUCTS LTD.

BOX No. ENG. 48, GREGORY'S BANK, WORCESTER, ENGLAND

Telephone: Worcester 6397 (3 lines). Telegrams: Redmans, Worcester.

STEEL PRODUCTS OF INTERNATIONAL REPUTE

South Durham in JAMAICA



Here is one small part of an installation of Welded Steel Precipitator Tanks in course of erection at Williamsfield, Jamaica, at the Kirkvine Works of Alumina Jamaica Ltd. The tanks were manufactured at the South Durham Malleable Works, Stockton-on-Tees.

After fabrication and test assembly at Stockton, the component parts were shipped to Jamaica. With them went a full crew of South Durham's trained erectors and welders whose tour of duty overseas has since covered the installation of one of the largest mineral processing plants in the western hemisphere.

Work on a similar Alumina Jamaica plant at Ewarton, is now nearing completion.

All over the world, South Durham Welded Steel Tanks and Pressure Vessels are serving a wide variety of industries and maintaining the national reputation for high quality products and good service.

Other South Durham manufactures include:
STEEL PLATES · STEEL RAILS AND ACCESSORIES · STEEL JOISTS AND SECTIONS BROAD FLANGE BEAMS LARSSEN STEEL PILING 'RENDHEX' FOUNDATION COLUMNS · STEEL PIPES STRUCTURAL STEELWORK ELECTRICALLY WELDED FABRICATIONS

The services of the South Durham Technical Advisory and Drawing Office Staffs are available at all times to engineers engaged in the planning or development of projects involving the use of any of the Company's products.

SOUTH DURHAM STEEL AND IRON COMPANY LIMITED

Central Sales Office: **CARGO FLEET IRON WORKS, MIDDLESBROUGH, YORKS.**

Telephone: Middlesbrough 2631 (14 lines). Telegrams and Cables: "Carfleco," Phone, Middlesbrough. Also at West Hartlepool, Stockton-on-Tees and London.

rotary positive blowers

gas boosters

vacuum pumps

vapour compressors

Manufactured to standard or unusual demands by

Hillside Foundry & Engineering Co. (Cupar) Ltd.

Sole licensees in Great Britain and the Commonwealth for the

Sutorbilt Corporation U.S.A.

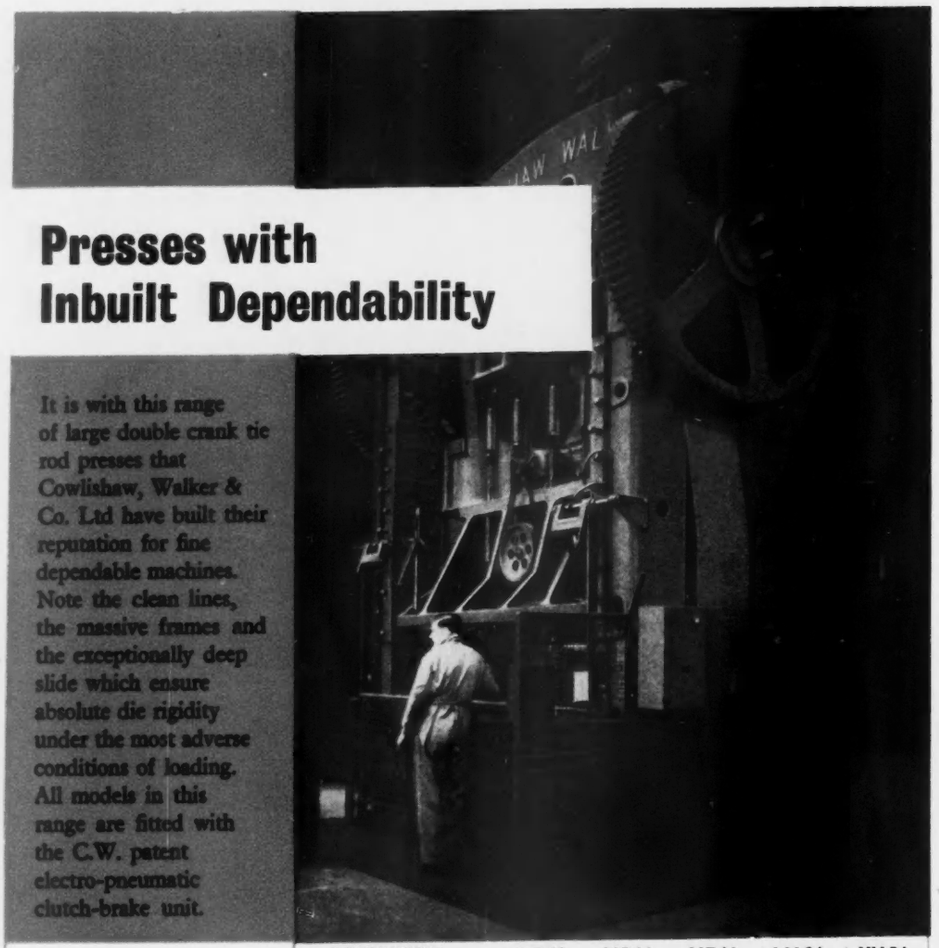
already operating in the following industries:

CHEMICALS · FOOD
COTTON · OIL
AIRCRAFT · FILMS
WASTE & SEWAGE
FOUNDRIES
CONSTRUCTION MINING

Send your enquiries to:

HILLSIDE FOUNDRY & ENGINEERING CO. (Cupar) LTD.

Hillside Foundry, Cupar, Fife
Tel: Cupar 2091/2



Presses with Inbuilt Dependability

It is with this range of large double crank tie rod presses that Cowlishaw, Walker & Co. Ltd have built their reputation for fine dependable machines. Note the clean lines, the massive frames and the exceptionally deep slide which ensure absolute die rigidity under the most adverse conditions of loading. All models in this range are fitted with the C.W. patent electro-pneumatic clutch-brake unit.

A selection from the range of C.W. double-crank presses

PRESS TYPE	OC.10	MF.14	UF.16	LN.24	YV.34
RATING: TONS	150	300	400	650	1500
CRANK DIA. ins.	7½	8½	10	12	15
BETWEEN SIDES ins.	75½	63	109½	109½	130½
STROKE ins.	10	14	16	24	34
SLIDE F to B x R to L ins.	30 x 68½	42 x 54	54 x 99½	63 x 99	70 x 120
BED F to B x R to L ins.	36 x 72	60 x 61	60 x 108	76 x 108	70 x 129
CUSHION: TONS	28	50	81	101	150

COWLISHAW, WALKER & CO. LIMITED

Biddulph, Stoke-on-Trent Telephone: Biddulph 3254 Telegrams: Cowlishaw, Stoke-on-Trent
London Office : 117 Victoria Street, Westminster, S.W.1 Telephone : Victoria 5472

SHEET METAL WORK & ENGINEERING FOR *EVERY INDUSTRY

For many years we have enjoyed a reputation for work of the highest quality and precision finish. Our spacious workshops house some of the most up-to-date metal working machinery and our resources are available to those who require prototypes or pilot runs as well as those whose demand is for quantity production.

***AUTOMOBILE**
Body panels, wings, cabs, silencers, petrol tanks, etc., etc.

***ELECTRONICS**
Main control cabinets, instrument panels and boxes, receiver chassis, etc.

***AIRCRAFT**
Fuel tanks, elevators, tail planes, pressings, fabrications in all metals.

Our Sheet Metal Working Plant includes:

Presses up to 200 tons, Guillotines, Wiring Machines, Press Brakes, Benders, Riveting and all types of Welding and General Engineering Plant.

E. G. Brown & Co., Ltd.

WEST ROAD, TOTTENHAM, LONDON, N.17

Telephone : TOTtenham 2257-8-9

LOW-TENSION A.C. AIR BREAK SWITCHGEAR

by

"One of thirty-six composite Switchboards which are being installed in the South of Scotland Electricity Board's Generating Station at Kincardine."

AIR-CIRCUIT BREAKERS, COPPER CONNECTIONS, AND BUS BARS TESTED IN ACCORDANCE WITH A.S.T.A. 16.

CONSULTING ENGINEERS - MESSRS. KENNEDY & DONKIN

FOR BOOKLET IF/2 WRITE TO

Manufacturers of Air Break Circuit Breakers for the past fifty years.

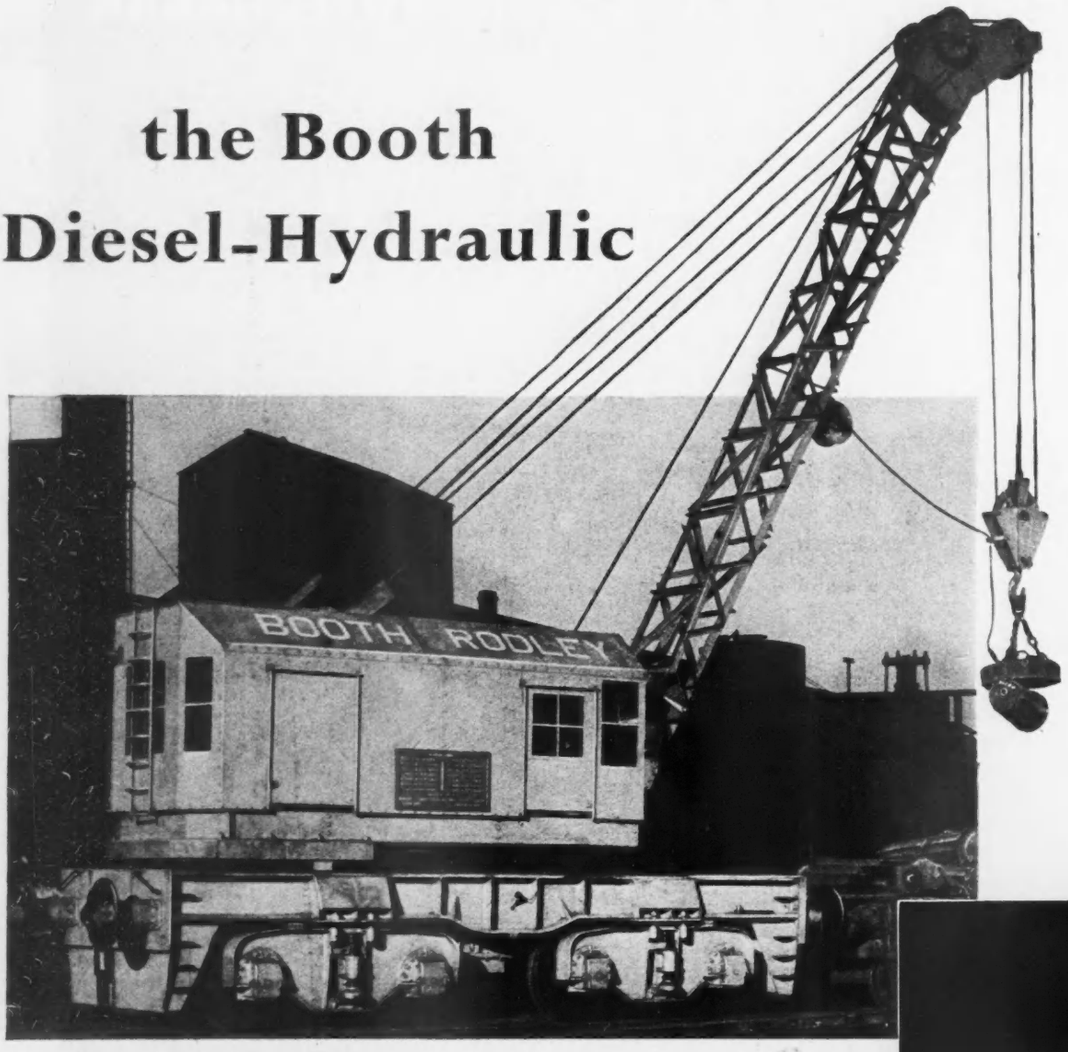
Whipp & Bourne Ltd

SWITCHGEAR WORKS CASTLETON · ROCHDALE · LANCS

D

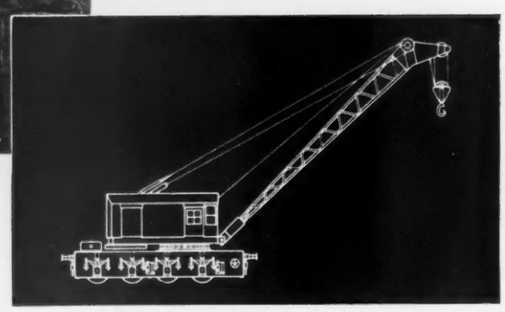
A completely NEW rail crane!

the Booth Diesel-Hydraulic



FEATURING . . . . .

- A hydraulic transmission system giving four speeds in either direction on travelling, hoisting and derricking motions.
- Compressed air controls are provided for quick response and easy operation.



Four axle carriage version for main line railway service

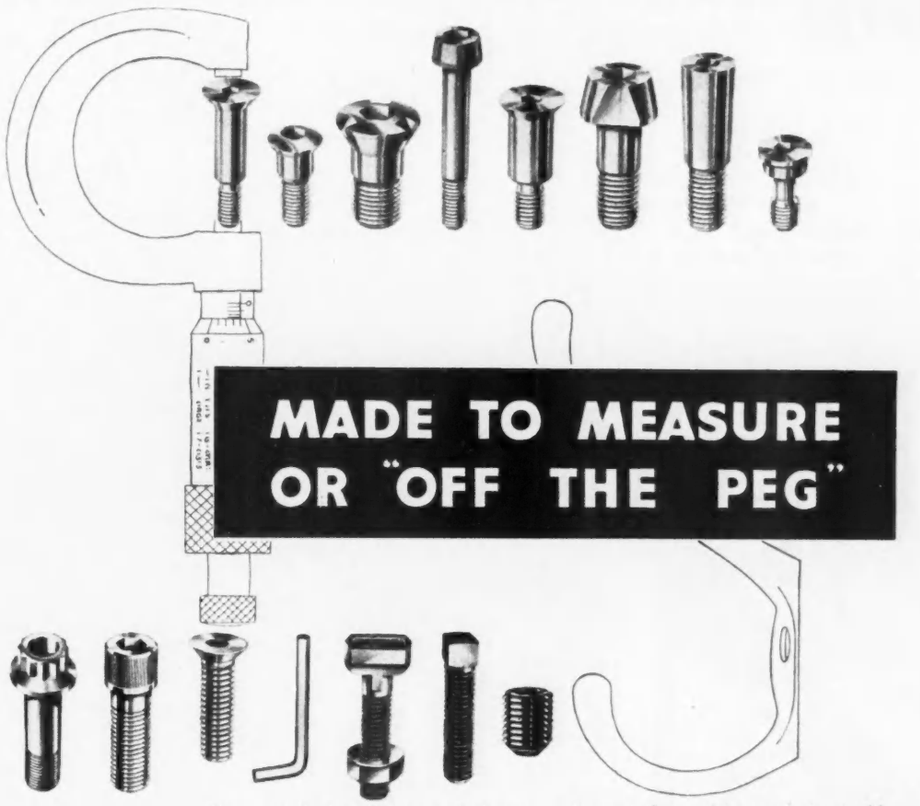
The Booth Diesel-Hydraulic Crane is the most up-to-date rail mounted crane in the world and the compact and efficient hydraulic transmission system is one of the most significant developments since the introduction of the Diesel driven locomotive crane.
Demonstrations can be arranged and full details obtained on application to Joseph Booth & Bros., Rodley, Leeds

CLYDE BOOTH

CLYDE CRANE & BOOTH LTD.
Incorporating:

Joseph Booth & Bros.,
Union Crane Works, RODLEY, Leeds.
Telephone: Pudsey 3168 (6 lines). Telegrams: "Cranes," Rodley.

Clyde Crane & Engineering Co.,
MOSSEND, Lanarkshire
Telephone: Holytown 412 (6 lines). Telegrams: "Clyde," Motherwell.



MADE TO MEASURE OR "OFF THE PEG"

You can nearly always find a screw in the vast Unbrako range calculated to do just what you want better than any other screw.

But modern developments sometimes call for special screws not even standard to Unbrako.

When that happens our highly trained team of fastener-minded experts really get enthusiastic, responding to the challenge. They like to co-operate with you at the blueprint stage for preference, helping to design the perfect screw for the job, or they will simply make the screw to your specification, just about as well as a screw can be made.

So, standard or special, you can always safely specify Unbrako, the people who offer the most comprehensive specialised screw service in the world.

To be on the safe side, better get in touch with Unbrako over any fastener question. Remember what they say — Unbrako screws cost less than trouble.

There are two Unbrako lists you should have in your library, and a postcard or telephone call will bring them by return. They form a detailed and comprehensive guide to the whole Unbrako range, standard and non-standard, and no progressive firm should be without them.

Unbrako screws cost less than trouble

UNBRAKO

UNBRAKO SOCKET SCREW COMPANY LIMITED · COVENTRY

THE IRONMONGER

ESTABLISHED IN 1859, THE IRONMONGER is in fact as well as by long tradition the leading weekly journal in the very wide field which it so thoroughly covers. Its interests include tools, workshop equipment, paints, general hardware, building goods, metals, electrical goods, and all ironmongery.

★

BUYERS OF WORKS STORES find that yearly subscription to THE IRONMONGER is an excellent investment. Week by week the journal keeps them abreast of current trends in production and design. All new goods are promptly and objectively described: and special editorial attention is consistently given to recording the development of fresh industrial technique.

★

TWO YEARBOOKS ARE INCLUDED in the subscription. One of these is the "Hardware Buyers Guide," which contains the trade's only comprehensive directory of manufacturers and their products. The other is "Branded Hardware," which is an A-to-Z index to some 33,000 branded lines, giving the manufacturers' addresses. A further service to subscribers is the Editorial Inquiry Department, which now answers "where to buy" inquiries at the rate of 900 a week. The subscription is £2 10s. a year.

Instructions and remittances should be addressed to

THE IRONMONGER

28 ESSEX STREET, LONDON, W.C.2

absterge
(to clean by wiping)

Austins supply the best cleaning rags for every purpose. Some jobs call for coarse, heavy fabric, some for soft, closely woven materials—we can meet all requirements with carefully selected rags that are thoroughly washed and sterilised in our own plant. Orders of all sizes are handled with promptness and reliability. Please let us quote you for regular supplies.

AUSTINS
industrial cleaning rags

E. AUSTIN & SONS (LONDON) LTD., GUN WHARF, GUNMAKERS LANE, E.3. Tel: ADVance 1211

Forgings

GEORGE MILLS (ENGINEERS) LTD. Established 1920
214-218 RAVENSCROFT RD., BECKENHAM, KENT. Telephone: SYDenham 5215

IN IRON & STEEL
UP TO 1¼ CWTS.

A.I.D. APPROVED
A.R.B. APPROVED

PROTOTYPES AND SPECIAL PURPOSE MACHINES

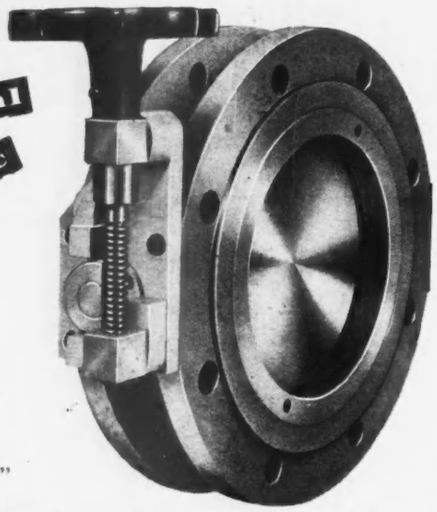
HEAVY AND "AWKWARD" MACHINING & GRINDING

REPAIRS & SALVAGE BY METAL DEPOSITION IN STELLITE, CHROME, NICKEL Etc.

WELDING FABRICATING PROFILE FLAME CUTTING AND GENERAL PRESSWORK

"FLEXISEAT"
PAT. Nº 753860
valves

positive seal
pivoted disc



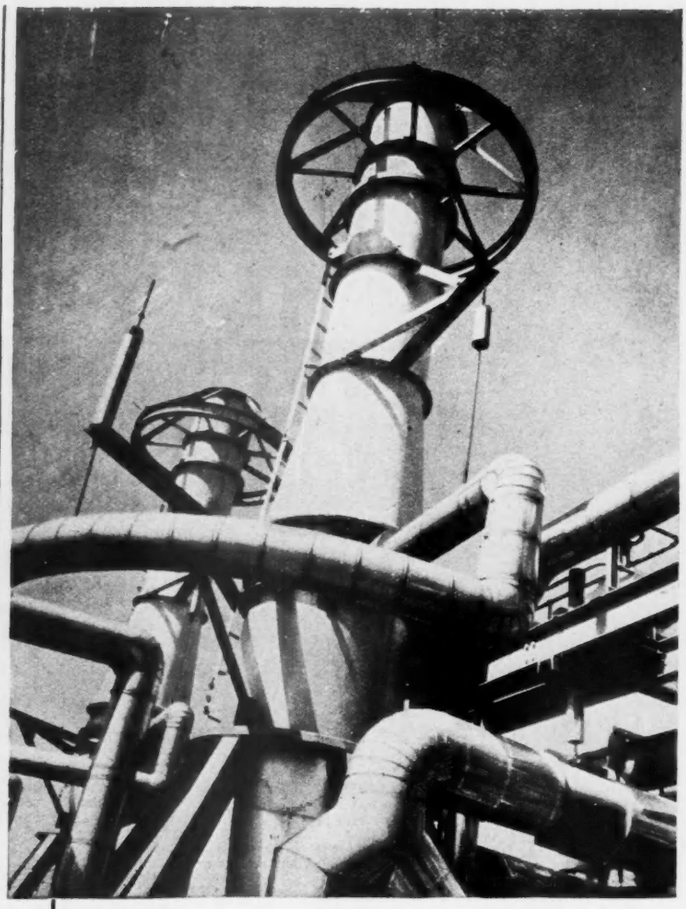
Suitable for Water, Oil, Paraffin, Air, etc., up to 150 P.S.I. Weight approx. ⅓ that of usual type of valve.

Standard "FLEXISEAT" Valves are supplied for test pressures up to 300 P.S.I. 3in., 4in. and 6in. sizes available from stock.

"Specials" up to 60in. bore can be made to customers' requirements in terms of pressure, temperature and material specification, etc.

Illustrated literature on request from the manufacturers.

WISEMAN & SWAIN VALVE CO. LTD.,
66 CASTLEFORD ROAD, BIRMINGHAM 11.
Telephone: VICtoria 4553.



GENSPRINGS
at Forth Chemicals

At the Grangemouth Works of Forth Chemicals, Vokes Genspring Variable Support Hangers provide safe, secure support for the long runs of piping.

These Variable Supports are complementary to the Vokes Genspring range of Constant Supports and are designed for use on pipelines where conditions are less critical, but where proper provision must be made for the effects of thermal expansion. Variable Gensprings are available in 16 sizes and include three travel ranges—1½", 3" and 6". Each of these three travel ranges covers the same load, i.e. 58-6895 lbs. Whatever the piping Vokes Genspring Variable Supports offer dependable control of vibration and limited thermal movement. Full details are available in our Catalogue which will be gladly sent on request.

with Vokes Genspring Variable Support Hangers:

* No springs to design
* Merely quote Catalogue number
* Delivered ready for erection
* Takes its correct design load

VOKES GENSPRING SUSPENSION SYSTEMS
DEPT. H/6 VOKES GENSPRING LTD · GUILDFORD · SURREY

VH/26

TEAMWORK

right from the start

This recent sculpture by David Wynne, F.R.S.A., for Taylor Woodrow has a very real significance for all who have new building in mind.

It was created primarily to symbolize the spirit of teamwork that pervades all levels of the Taylor Woodrow organization, the enthusiasm and drive that so often completes contracts well ahead of meticulously planned and therefore very tight schedules. But it also symbolizes a new dynamic in building — that of bringing Taylor Woodrow into full collaboration with your consultants right from the start. This we call Tayplanning, which brings to your new project a degree of efficiency and speed obtainable in no other way.

TAYPLANNING saves time — a great deal of time. Design problems — which today are often construction problems too — can be studied by Taylor Woodrow specialists in the light of their world-wide experience of new and advanced construction techniques. The whole project is streamlined into a single, perfectly co-ordinated master-plan — to meet the standards all building owners require — highest quality construction, economy of design and execution and completion in the shortest possible time.

We welcome an opportunity of discussing Tayplanning with you. You will find that it adapts itself to your special needs and requirements.

TAYLOR WOODROW

BUILD EVERYWHERE

BUILDING AND CIVIL ENGINEERING CONTRACTORS

10 PARK STREET · LONDON W1 · GROSVENOR 8871

UNITED KINGDOM · CANADA · AFRICA · MIDDLE EAST · BRITISH WEST INDIES · AUSTRALIA · FIJI

SHATTER PROOF

Try This Test

Epimastic's toughness is only matched by its adhesion to metal. Above—showing a plate bent almost double without any loss of adhesion between coating and metal surface.

Few coatings resist the hard knocks of a full working life. Mechanical damage is a short cut to the subsequent failure of any coating and no engineer can afford to take risks. Epimastic has been found to withstand an amazing amount of abrasion and rough treatment and yet still provide an efficient protection against corrosion.

Solvent and moisture proof, resistant to all manner of corrosive chemical conditions, Epimastic will probably provide the answer to your corrosion problem. Write today for Technical Leaflet No. 20.

EPIMASTIC

Toughest Ever Bituminous Coating

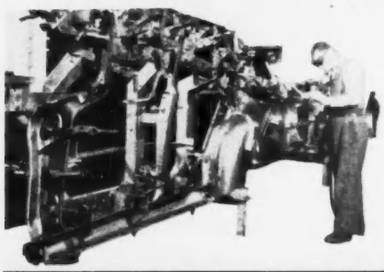
WAILES DOVE BITUMASTIC LIMITED · HEBBURN · CO. DURHAM 166

JIGS & TOOLS

We specialise in the design and production of jigs and tools to extreme accuracy. A highly qualified staff is always available and at your service.

Get in touch with us.

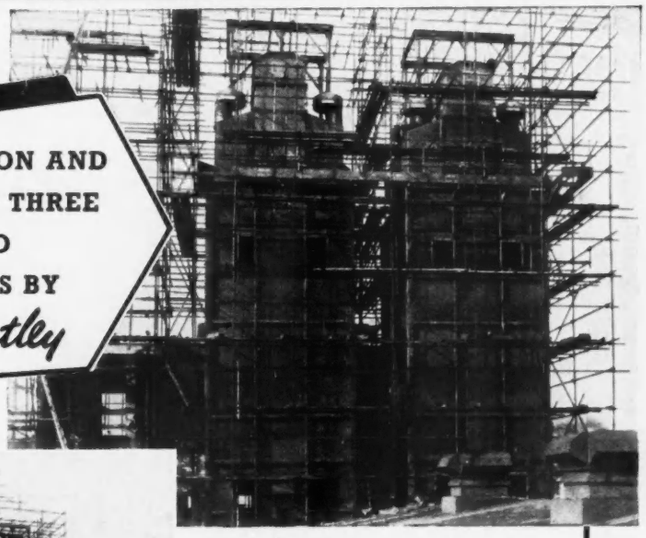
BIRMINGHAM & BLACKBURN Construction Co. Ltd.

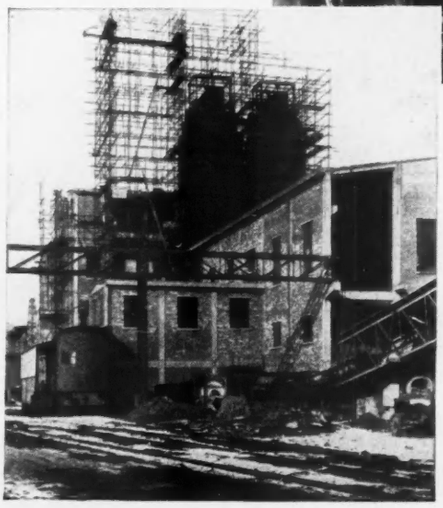


ARMOURY CLOSE, BORDESLEY GREEN, BIRMINGHAM 9.

AND AT GEORGE ST. WEST, BLACKBURN.

CONSTRUCTION AND ERECTION OF THREE DUST ELECTRO PRECIPITATORS BY *Rileys of Batley*





Above: A close-up view of the upper parts of the two Precipitators.

Left: The erection of two of the three Precipitators nearing completion. Their overall height from ground level is 92 feet and we erected scaffolding to a height of 120 feet for the job.

These photographs and details are published by courtesy of the National Coal Board, South-Western Division, and the Main Contractors, Messrs. Simon Carves Ltd., Precipitator Division, Cheadle Heath, Stockport.

the complete manufacture of the sections and component parts was undertaken at our works and erected on site by our own staff

Consult Rileys of Batley for the design, manufacture, supply and erection of Plant and Equipment, as well as all requisite auxiliaries. We offer a comprehensive service to the Chemical, Fuel, Power, Petroleum, By-Products, and other Industries.

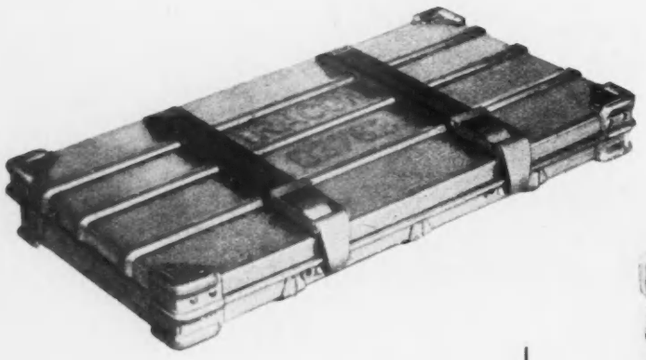
A. J. RILEY & SON LTD

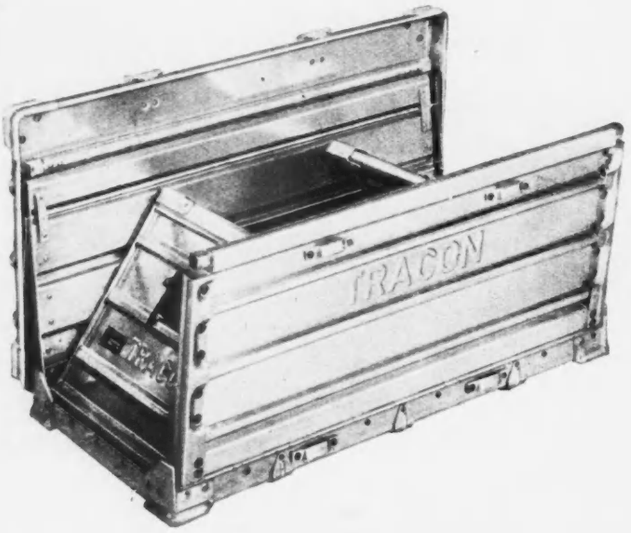
Victoria Works, Batley, Yorkshire

Telephone: Batley 657 (3 lines) *Telegrams: Boilers, Batley*

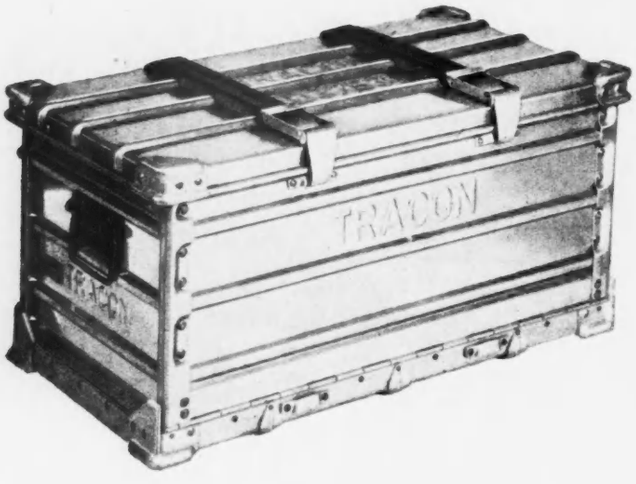
BRITISH ALUMINIUM

FOR MATERIALS HANDLING CONTAINERS





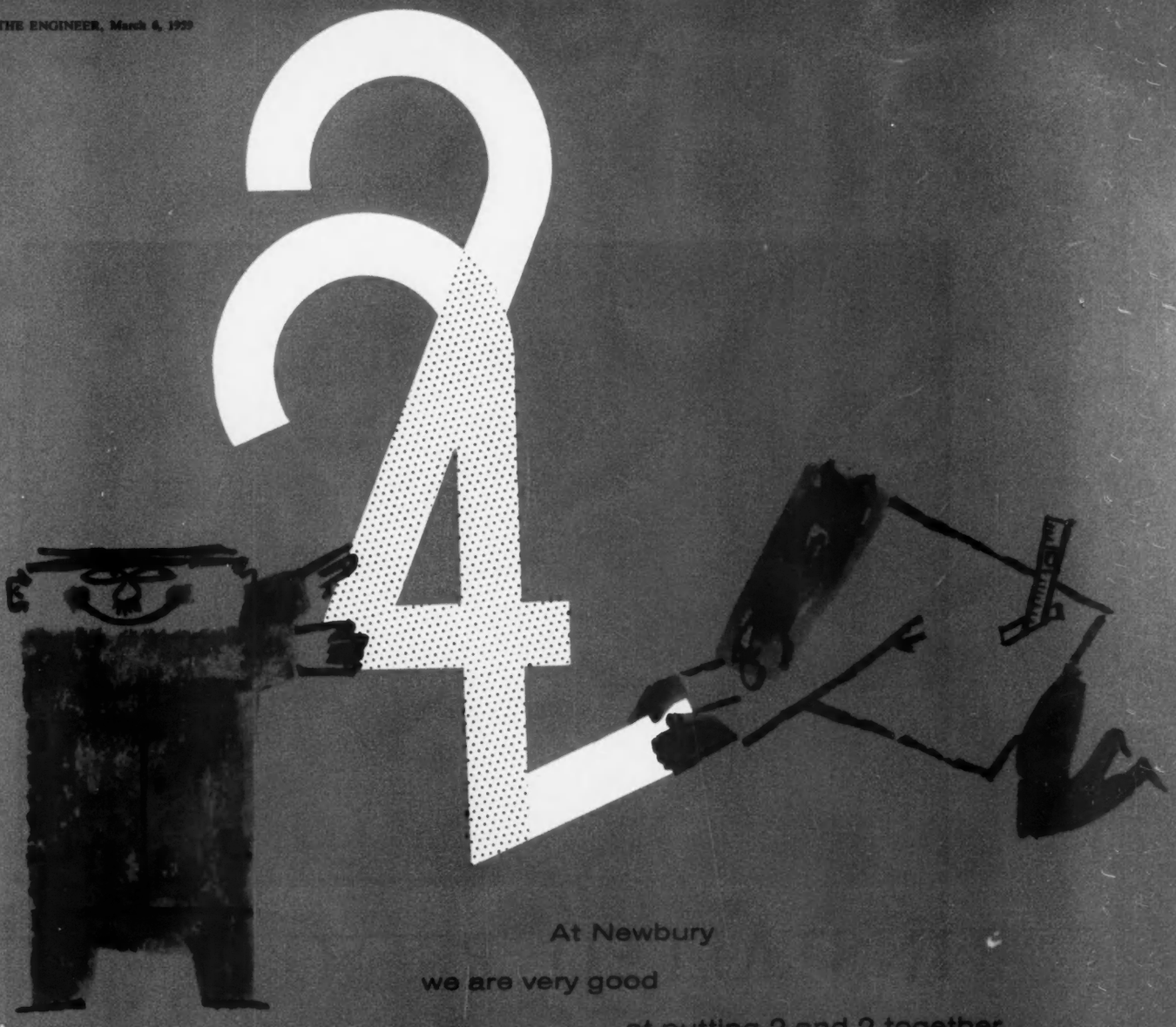
The Tracon collapsible container, produced by Light Alloy Construction Ltd of Carnmoney and Darlington, offers manufacturers an ideal means of packing and transporting an infinite variety of products. These lightweight containers, made of British Aluminium, are pilfer-proof and resist the roughest handling; in addition they may be collapsed for return into one fifth of their box volume.



The BRITISH ALUMINIUM Co Ltd

NORFOLK HOUSE ST JAMES'S SQUARE LONDON SW1

AP201



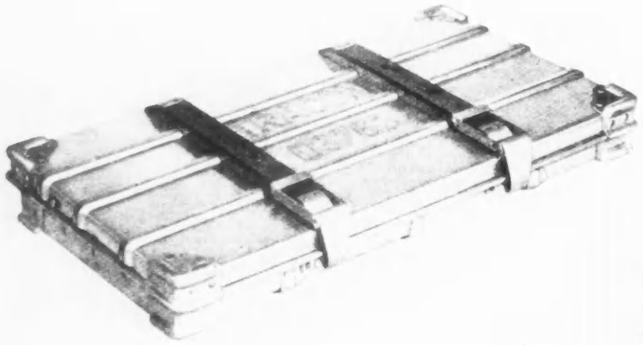
At Newbury
we are very good
at putting 2 and 2 together
and making 4 (as you can see).
That is why we welcome any kind of gearing problem.
It might be that the answer
lies in one of our standard range of units,
but if not, the experience of our
team of engineers and designers
is always at your service
to design and produce
the perfect unit for the job.

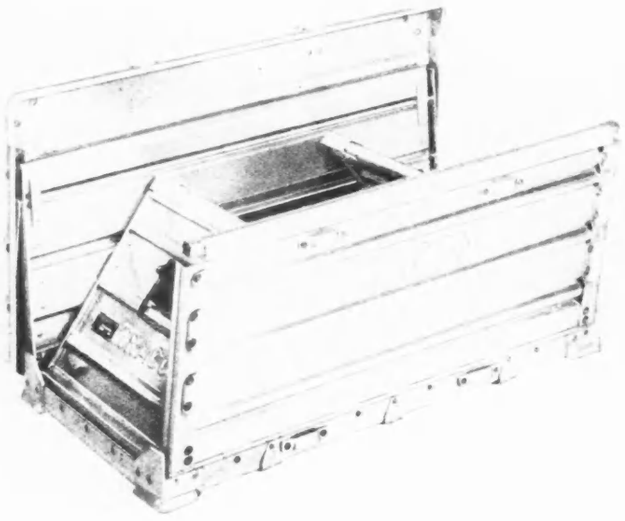
OPPERMANS
of NEWBURY

OPPERMAN GEARS LTD NEWBURY BERKSHIRE Telephone Newbury 1701 Telegrams Oppigears Newbury

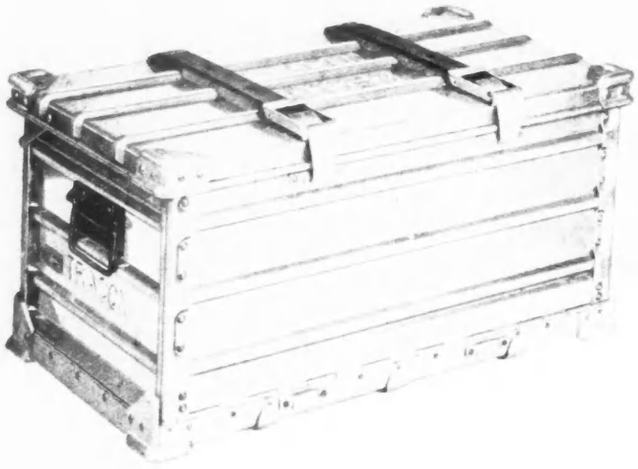
BRITISH ALUMINIUM

FOR MATERIALS HANDLING CONTAINERS



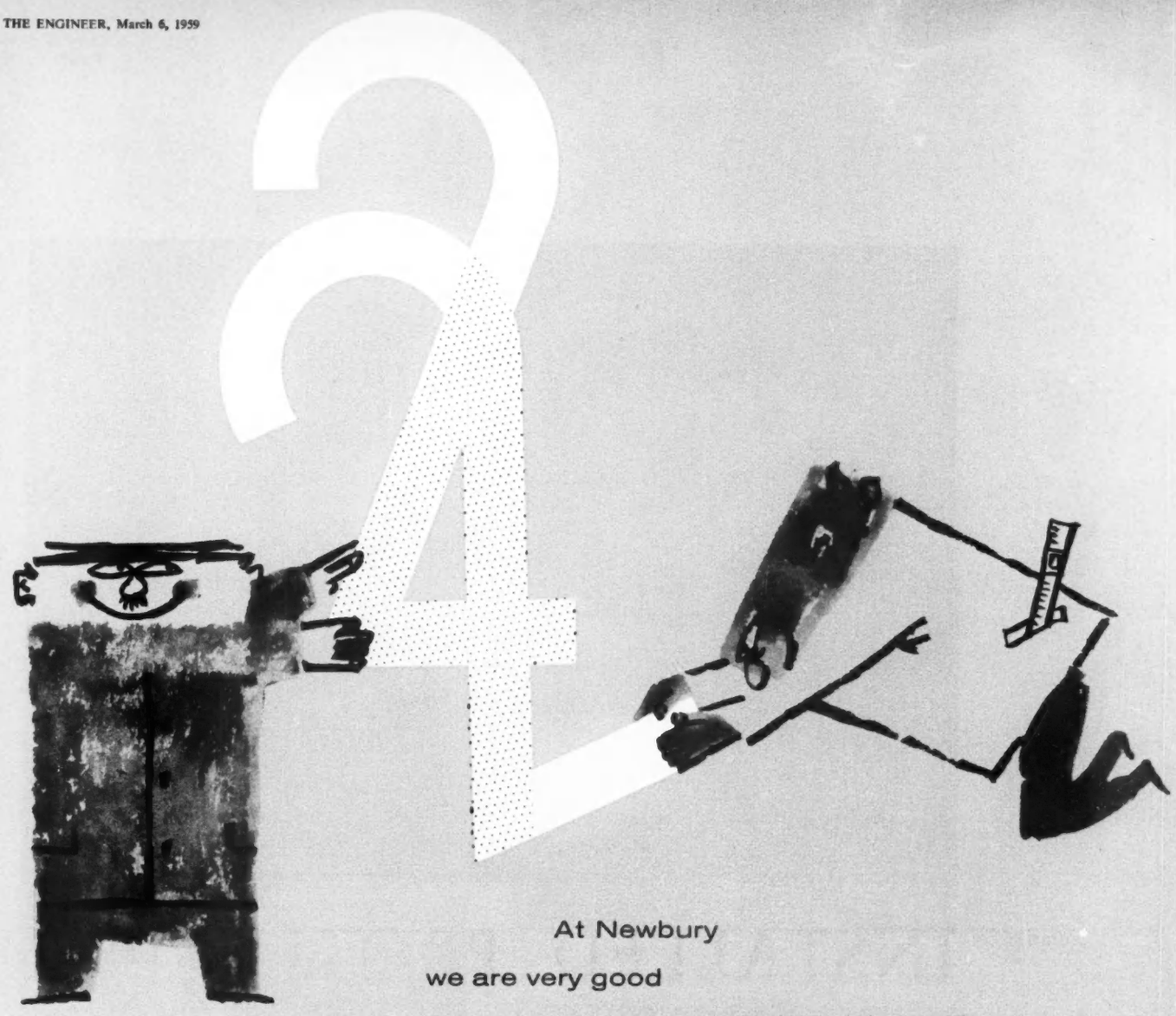


The Tracon collapsible container, produced by Light Alloy Construction Ltd of Carnmoney and Darlington, offers manufacturers an ideal means of packing and transporting an infinite variety of products. These lightweight containers, made of British Aluminium, are pilfer-proof and resist the roughest handling; in addition they may be collapsed for return into one fifth of their box volume.



The BRITISH ALUMINIUM Co Ltd

NORFOLK HOUSE ST JAMES'S SQUARE LONDON SW1



At Newbury
we are very good
at putting 2 and 2 together
and making 4 (as you can see).
That is why we welcome any kind of gearing problem.
It might be that the answer
lies in one of our standard range of units,
but if not, the experience of our
team of engineers and designers
is always at your service
to design and produce
the perfect unit for the job.

OPPERMANS
of NEWBURY

OPPERMAN GEARS LTD NEWBURY BERKSHIRE Telephone Newbury 1701 Telegrams Oppigears Newbury

INSTALLED PROTECTION

Buried or submerged pipelines are generally exposed to corrosive influences which, unless checked, may weaken the line and ultimately cause failure. S & L steel pipes for use in such conditions are protected externally with a sheathing of bitumen-asbestos compound which, if kept intact, is an adequate protection against corrosion.

Rough handling in transportation and during the process of laying is almost inevitable. If the pipe installed in position is to remain resistant to corrosion, the protective sheath must be tough enough to withstand the normal hazards of transport by road, rail or ship, and any accidental blows associated with standard pipe-laying practice.

The new woven-glass-reinforced sheathing, devised and introduced by Stewarts and Lloyds, has proved itself to be the answer to the problems of ensuring efficient protection against corrosion of the INSTALLED pipe. The mechanical strength of standard bitumen-asbestos sheathing is greatly increased by a wrapping of woven glass cloth. This is applied concurrently with hot bitumen-asbestos mastic and embedded just below the surface.

The glass cloth is manufactured entirely from glass fibres loosely twisted into a yarn

STEWARTS

which is woven to give an open mesh fabric somewhat similar, as regards gauge and mesh, to hessian cloth. The fabric is inert, electrically non-conducting and has a high tensile strength.

This woven-glass-reinforced sheathing will withstand sharp blows without damage, and even under harsh treatment the damage is confined to a superficial layer outside the glass wrap, leaving ample thickness of protective material for the corrosion-resistant property of the protection to remain unimpaired.

On completion of the jointing at site, the protective sheathing can easily be made continuous by pouring a specially prepared bituminous compound into a mould (the usual method where Viking Johnson couplings are used) or by other suitable wrapping or moulding techniques where the joints are welded.

The following pipelines recently installed in Britain are protected with Stewarts and Lloyds woven-glass-reinforced sheathing :—

City and County of Kingston upon Hull Water Department. River Hull Scheme.
15 miles of 36 in.-33 in.-30 in. steel main.

The North Thames Gas Board, for the Shellhaven to Romford Refinery Gas pipeline.
18 miles of 24 in. steel main.

The Southern Gas Board, Integration Main.
13 miles of 18 in. and 15 miles of 16 in. steel main.

Where drainage tests have been carried out in conjunction with cathodic protection, results have shown a remarkably low current consumption—a convincing proof of the efficiency of the INSTALLED protection.

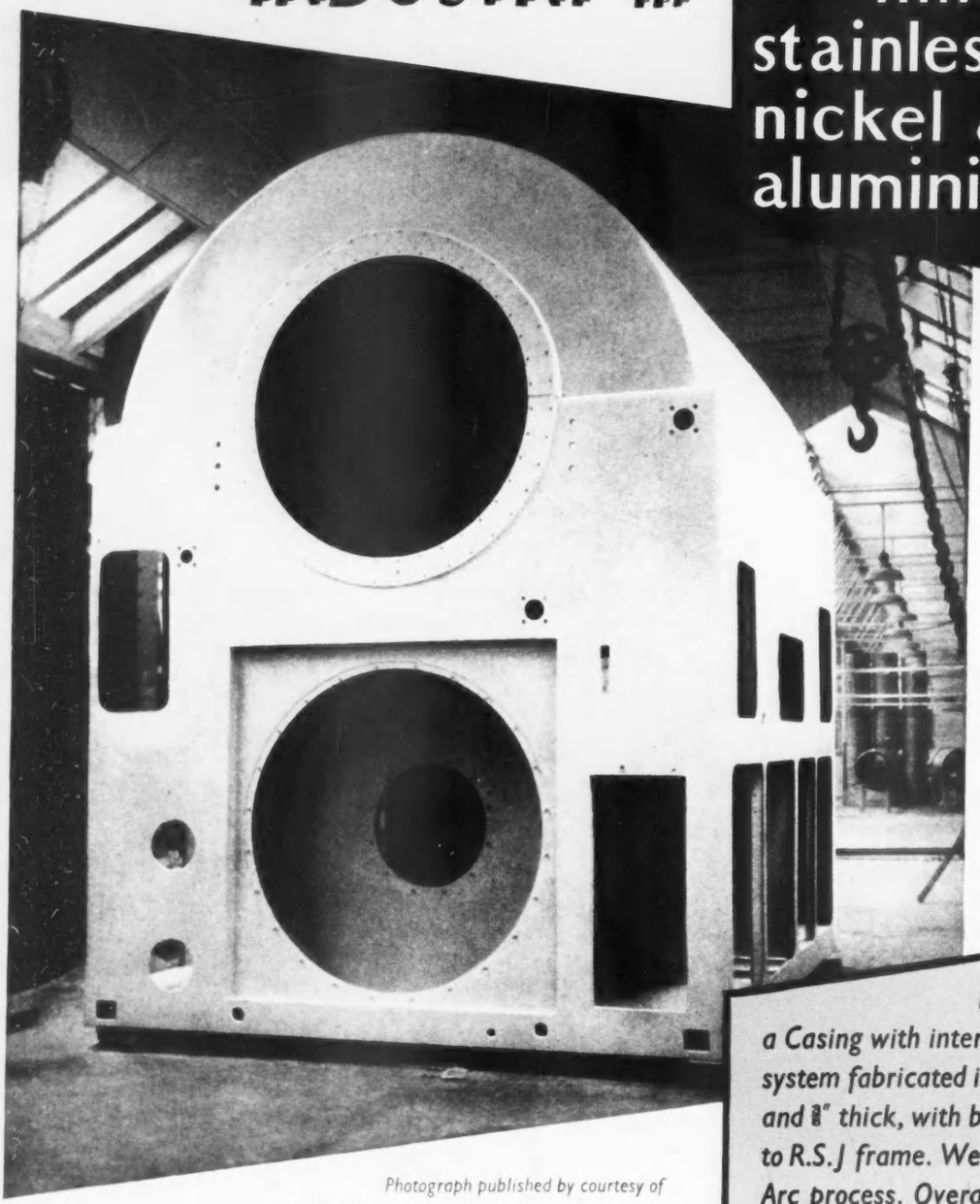
S&L

AND LLOYDS LIMITED

GLASGOW • BIRMINGHAM • LONDON

FABRICATORS to INDUSTRY in

···· mild steel, stainless steel, nickel and aluminium etc.



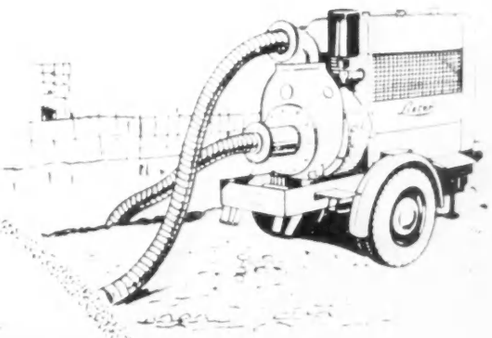
Photograph published by courtesy of Messrs. Sutcliffe Speakman Co.Ltd, Leigh, Lancs

Illustration shows a Casing with internal baffle and fan system fabricated in mild steel ⅛", ¼" and ⅜" thick, with base sheets welded to R.S.J frame. Welded by Metallic-Arc process. Overall Dimensions approx : 12' long x 8' wide x 12' high Weight 7 tons.

UNIVERSAL BOILERS & ENGINEERING CO. LTD

HEAD OFFICE: FULLEDGE WORKS BURNLEY LANCASHIRE ENGLAND
Telephone: 3121/2 and 3203 Burnley (3 Lines) Telegrams: 'UNIVERSAL' Burnley

Associated with BURNLEY AIRCRAFT PRODUCTS LTD. Fulledge Works Burnley Telephone 3121/2
GROSVENOR STREET, STONEYHOLME, BURNLEY Telephone 3184
and BRITANNIA WORKS, QUEENSGATE, BURNLEY Telephone 4102



CONTRACTORS PLANT

PUMPING

Power

ELECTRICITY STAND BY

QUARRIES

for all these purposes

and many more is provided economically and efficiently by

LISTER

AIR-COOLED DIESEL ENGINES

AGRICULTURE

MINING

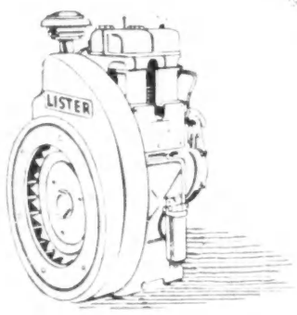
WATER PURIFICATION

NAVIGATIONAL AIDS

COMMUNICATIONS

REFRIGERATION

If you need power may we put forward proposals? Air-cooled diesel engines up to 30 h.p. Other diesel engines up to 1320 h.p.

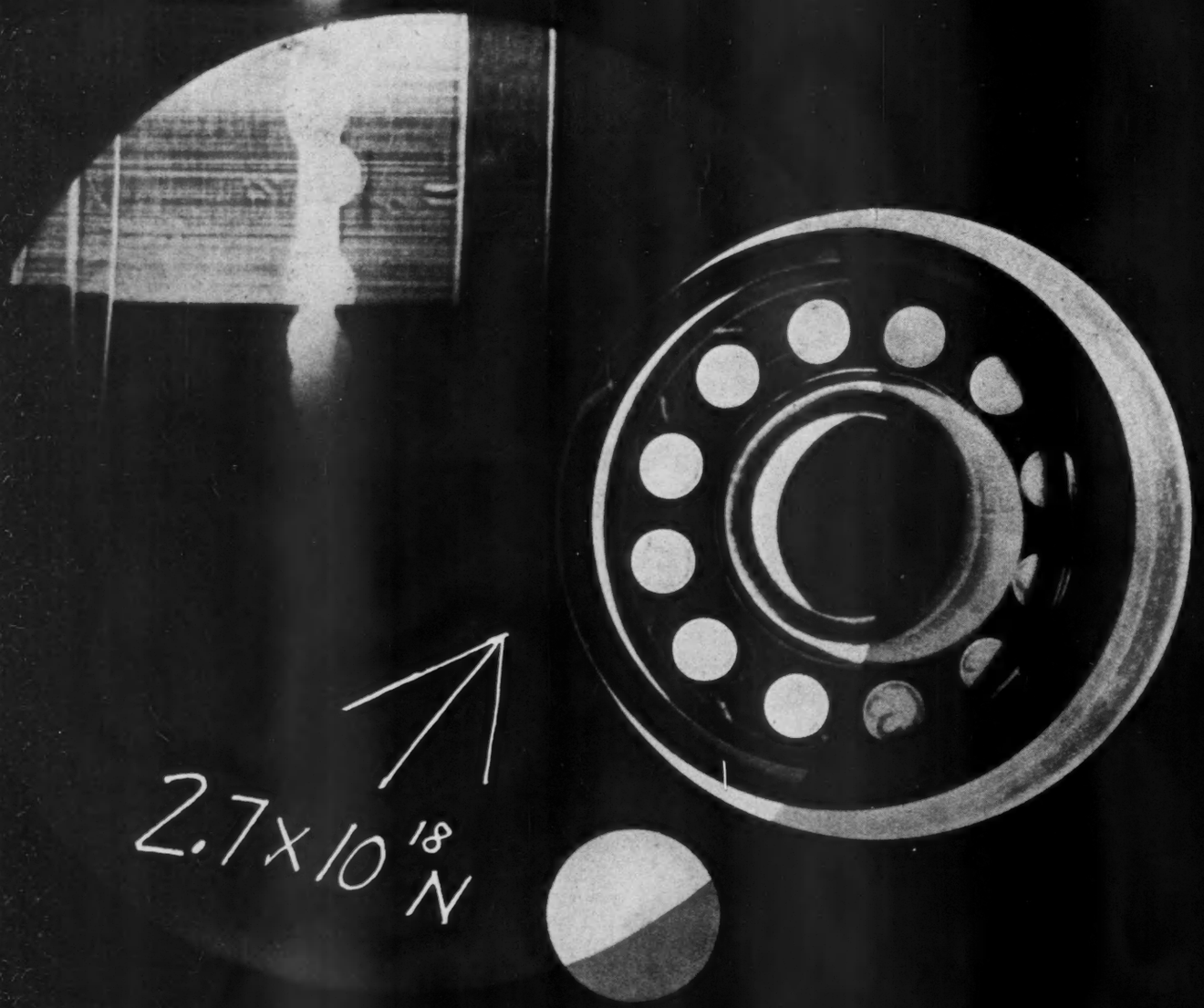


R. A. LISTER & CO. LTD.

DURSLEY, GLOUCESTERSHIRE. Phone 2371

Branches: London, Stamford, Glasgow, Dublin

APL greases passed



the final test...

Radiation broke up the gel structure of conventional greases. They lost their lubricating properties, turned fluid or granulated. Completely new kinds of greases were needed by the atomic power industry for the bearings situated within the radiation field.

The Shell Group started working out radiation-resistant APL greases whilst most nuclear power stations were still on the drawing-board, and the research that went into them is characteristic of the way Shell set about doing things.

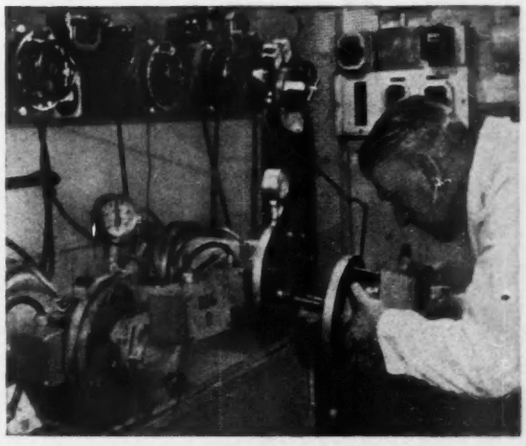
A team of research workers was assembled at Shell's Research Centre at Thornton. After four years of research and testing – both at Thornton and the A.E.R.E. Harwell – APL greases were ready for their finals. A sample was packed into a bearing and sunk into the B.E.P.O. pile. There it was not only subjected to mechanical working and high temperatures in CO_2, but also to an integrated pile dosage of 2.7×10^{18} thermal N. per sq. cm. plus associated radiation. APL greases sailed through their finals – and Shell are proud of it. They should be. For with these greases, Shell completed Britain's first range of Atomic Power Lubricants.

The moral of the APL story is that Shell research is supremely applicational. The Centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right lubricant for the job. If you and your organisation have any major lubrication problem, it will pay you to get in touch with your local distributor of Shell Industrial Lubricants.

The Research Story

Naturally a whole variety of greases were investigated. Conventional metallic soap greases were affected even by relatively low levels of radiation. Other greases based on synthetic and non-petroleum materials were examined and found to be equally unstable. Some of them softened appreciably and became tacky, whilst others hardened.

The Shell APL 700 series of greases are specially processed with an inorganic gelling agent, the base lubricant used being similar to the APL oils previously proved highly resistant to radiation. There were three series of tests. First tests were preliminary radiation tests at Harwell. Then the greases were tested for their lubricating qualities in a high temperature (400°F) pressurised CO_2 anti-friction bearing rig turning at 1,500 r.p.m. For the final tests, actual working conditions were simulated at Harwell.



SHELL

ATOMIC POWER LUBRICANTS

another proof of Shell leadership in lubrication

SHOT BLAST PLANTS

with

SHOT THROWING WHEELS

or

AIR NOZZLES

Over 50 years experience embodied in design and manufacture

ST. GEORGES ENGINEERS LTD., ORDSALL LANE, MANCHESTER 5

Telephone: TRAfford Park 1207 (4 lines). *Telegrams "Georgic" Manchester 5*

arteries of industry

As the development of world resources accelerates—extra shipping, refinery investment, industrial expansion, nuclear applications—the demand for top quality pipework increases.

INDUSTRIAL · MARINE · REFINERY · NUCLEAR

Top quality pipework? That's where Lawrie's step in. For many years we have been producing fabricated pipework to B.S. and A.P.I. standards, our welding is approved by Lloyd's and other inspecting authorities, and we are on the approved list of pipework contractors to the U.K. Atomic Energy Authority.

PUT YOUR PIPEWORK PROBLEMS TO LAWRIE

J. & T. LAWRIE LIMITED · LIVINGSTONE STREET · CLYDEBANK · SCOTLAND *Tel: Clydebank 2171/2/3*

and associate company William Wilson & Sons (Port Glasgow) Ltd., East Bay Industrial Estate · Port Glasgow. *Telephone: 41050.*

London Office: 34 Victoria Street, London, S.W.1. *Telephones: ABBey 4937 and 1847.*

Dust & Grit Collectors

A new addition to the range of A. & O. dust and grit collectors.

This photograph shows an Alldays & Onions grit arrester hood applied to an A. & O. hearth designed to meet the requirements of the Clean Air Act. There is also a grit arrester available for fitting to existing hearths.

ALLDAYS & ONIONS LTD

GREAT WESTERN WORKS, BIRMINGHAM 11.
Phone: VICtoria 2251-4
LONDON OFFICE: 2, QUEEN ANNE'S GATE, WESTMINSTER, LONDON S.W.1.
Phone: WHitehall 1923-4-5

BIRKETT

Safety Valves

Patent Pending

Fig. 356

FOR SUPERIOR PERFORMANCES

- Pop type Safety Valves conforming to BSS 1123
- Prompt Blow-off
- High Discharge Capacity
- Snap Reseating
- Sizes ½" to 4"
- Pressures up to 3,200 lbs. per square inch
- Screwed or Flanged
- Open or Side Outlet Types
- Air-under-water Tested

Fitted as standard by many of the leading Air Compressor makers.

SAMUEL BIRKETT LTD

QUEEN STREET WORKS
HECKMONDWIKE YORKSHIRE
Telephone: Heckmondwike 1241-2-3

10 ton Steam Permanent Way Crane. Metre Gauge. Duty: 10 tons at 16 ft. radius propped; 5 tons at 14 ft. radius free

3 Motor, electrically operated Fixed Wharf Crane. Duty: 15 tons at 22 ft. radius.

T&H

CRANES

STEAM
DIESEL
DIESEL-ELECTRIC
ELECTRIC

TAYLOR & HUBBARD LTD
KENT STREET LEICESTER

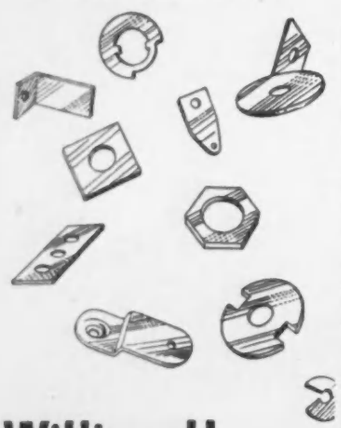
Telegraphic Address: "Lifting, Leicester"

Telephone Nos.: 22575-6

PRESSINGS
In all Metals, Bakelite and Fibre.

PRESSED NUTS
In Brass and Steel.

WASHERS
In any metal, plain and press bevelled.



William H.
SMALL
Limited
WRIGHT STREET
SMALL HEATH
BIRMINGHAM
10.

Phone: VICtoria 4091-2-3 (three lines)
Grams: "Washnuts Birmingham 10"

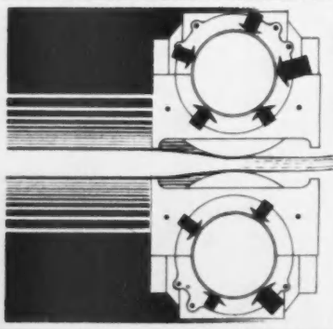
G.E.C. 'LIMPET' LANTERN
for SIDE ROAD lighting

The lantern has been designed for side road lighting using two 60 watt Osram Tungsten Lamps or one 80 watt Osram Mercury MB/U or MBF/U Lamp.

New features include :—

- ✳ Die-cast light alloy body arranged for wall mounting, thus dispensing with the necessity for columns and the obstruction they might cause in certain situations.
- ✳ Lamp operating gear, where necessary, housed within the body.
- ✳ Lantern enclosed by a diffusing opal "Perspex" bowl secured by a quick release toggle catch.
- ✳ All surfaces smooth for ease of cleaning.

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2



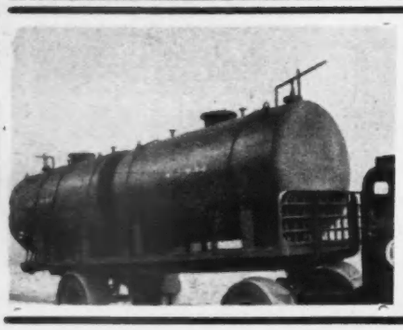
IRONSIDES
rolling mill
LUBRICANTS

IRONSIDES SHIELD PRODUCT

Keeps 'em rolling

THE IRONSIDES LUBRICANTS LIMITED · DAW BANK · STOCKPORT · CHESHIRE

CW5925



PRESSURE VESSELS · TANKS
DUCTWORK · CHIMNEYS · CYCLONES
CENTRIFUGAL FANS · STEELWORK

FABRICATED PLATEWORK and SUPPORTS
DESIGNED, MANUFACTURED & INSTALLED

SUPERWELDS (LEWISHAM) **LTD.**

Princes Rd, Dartford *Tel: DARTFORD 6333*

2 IMPORTANT DEMINERALISATION PLANTS

William Boby & Co. Ltd. have been entrusted with the execution of the demineralisation water treatment plants at:

1 CHEMSTRAND LTD., N. Ireland

(Main Contractors: Messrs. Constructors John Brown)

For their new 'ACRILAN' factory at Coleraine, N. Ireland, Messrs. Chemstrand have installed a 10,000 galls/hr. 'Boby' demineralisation plant for process and boiler feed water.

The plant comprises the following sections:

Coagulation and Settlement—Filtration—Cation Exchange—Weakly basic Anion Exchange—Degassing—Mixed Bed Ion Exchange.

2 VEITSILUOTO O/Y, Finland

The Veitsiluoto paper mills of Finland have installed a 13,400 galls/hr. 'Boby, demineralisation water treatment plant for feed water for boiler working at 1,750 p.s.i.

The plant comprises the following sections:

Coagulation and Settlement—Filtration—Cation Exchange—Weakly basic Anion Exchange—Strongly basic Anion Exchange.

WATER **BOBY** TREATMENT

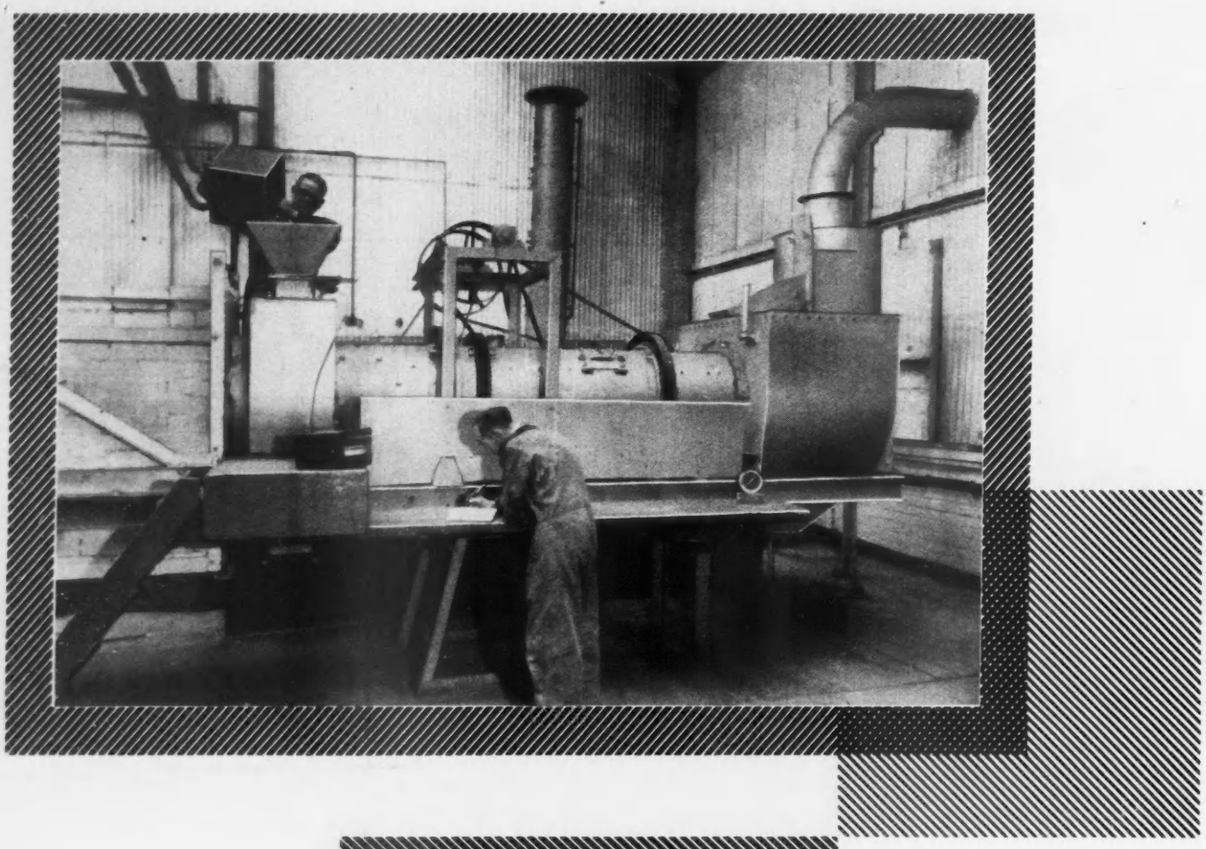
WILLIAM BOBY & CO. LTD.

RICKMANSWORTH, HERTFORDSHIRE, ENGLAND

Telephone: Rickmansworth 4251*

Established in 1875

EVERY MATERIAL IS A PROBLEM ON ITS OWN



EDGAR ALLEN & CO LIMITED

That is why Edgar Allen & Co. Limited have set up an Experimental Department to process samples of materials from customers. Once experiments have been carried out, Edgar Allen & Co. Limited are able not only to suggest the machines you need, but to report on the results you can expect once the plant is in full production. The Experimental Department can save you time and money and is typical of the service offered to you by Edgar Allen & Co. Limited.

You can witness experiments on your own materials if you have a problem of

CRUSHING
CALCINING
DRYING
GRINDING
PULVERIZING
SEPARATING

Write for further details

To EDGAR ALLEN & CO. LTD.
SHEFFIELD 9 Er ED64

Please send details of.....to
(Insert Choice)

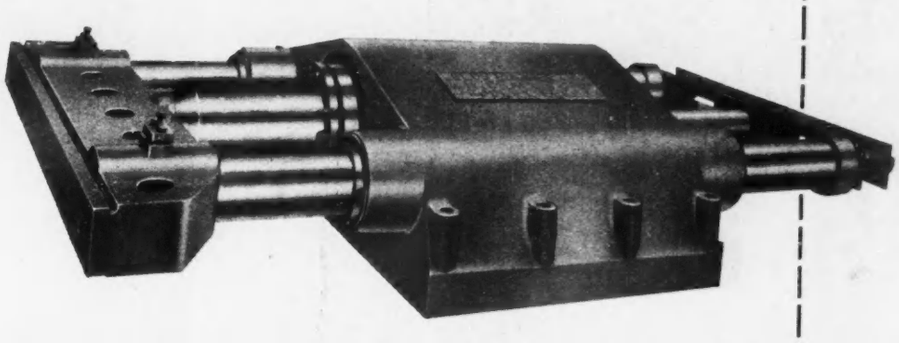
Name .....
Position .....
Firm.....
Address .....

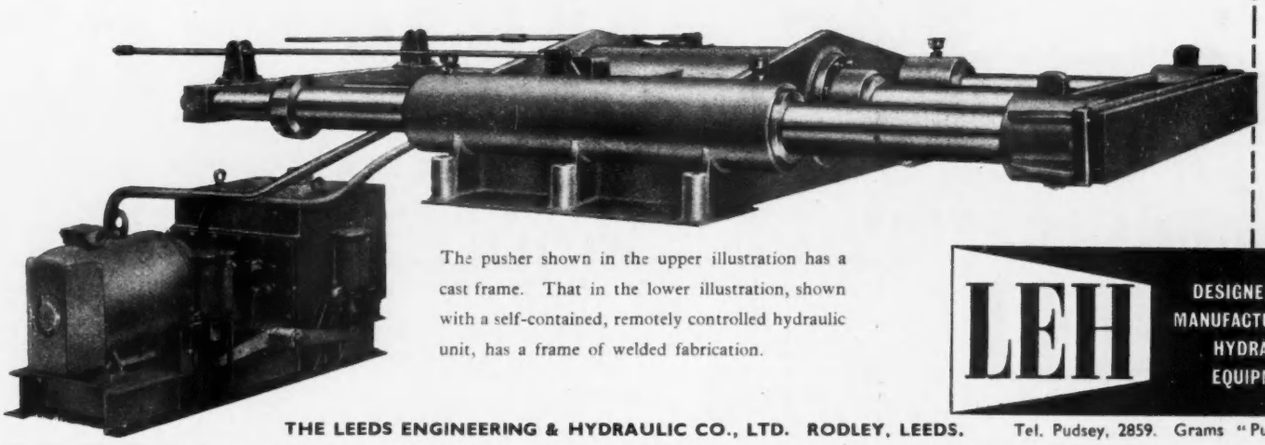
Edgar Allen & Co. Limited
IMPERIAL STEEL WORKS · SHEFFIELD · 9

Post the coupon to-day for this Booklet

LEH FURNACE PUSHERS

Typical of robust L E.H. design, these hydraulic furnace pushers are ideally suited to steelworks duty where unfailing reliability under arduous conditions is of prime importance.





The pusher shown in the upper illustration has a cast frame. That in the lower illustration, shown with a self-contained, remotely controlled hydraulic unit, has a frame of welded fabrication.

LEH DESIGNERS AND MANUFACTURERS OF HYDRAULIC EQUIPMENT

THE LEEDS ENGINEERING & HYDRAULIC CO., LTD. RODLEY, LEEDS. Tel. Pudsey, 2859. Grams "Pumps," Rodley

Foden

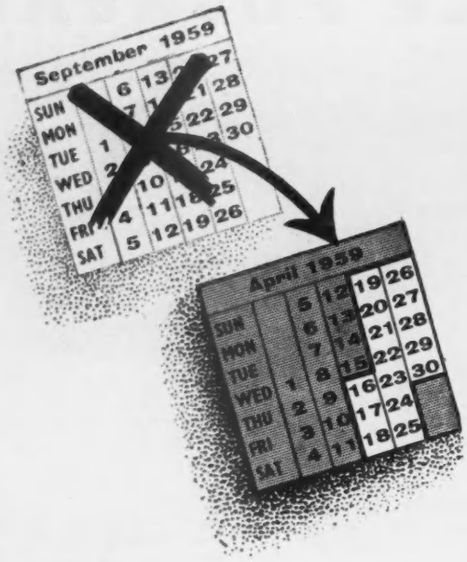
K TYPE HIGHWAY MODEL

Modern technique and materials have enabled us to produce this brilliant new Foden 8 wheeler, offering the highest possible payload consistent with strength and durability.

17½ TON LEGAL PAYLOAD
150 H.P. ENGINE
AIR BRAKES ON ALL WHEELS
—AND FODEN DEPENDABILITY

FODENS LIMITED · SANDBACH · CHESHIRE
Telephone: SANDBACH 644 (12 lines)
London Sales Office: 139 Park Lane, W.1
Telephone: Grosvenor 5932 1316 ®

A Popular Change of Date



ENGINEERING marine, welding & nuclear energy EXHIBITION

The largest event of its kind in the world

If you are an Engineer - of whatever kind - this is YOUR Exhibition. In Olympia on a floor space of over a quarter of a million square feet, over 500 of the world's leading manufacturers will show their most up-to-date equipment for your benefit. This Exhibition has been internationally famous for over 50 years. It occurs only once every two years. Previously it has been held in September, but in 1959 for the first time it has been possible to meet the popular demand for the Exhibition to be staged in the Spring of the year.

OLYMPIA · LONDON

APRIL 16th - 30th, 1959

Opening hours: April 27th, 28th, 29th — 10 a.m. to 8 p.m.
ALL OTHER DAYS—10 a.m. to 6 p.m. CLOSED SUNDAYS

ORGANISED BY F. W. BRIDGES & SONS LTD
Grand Buildings, Trafalgar Square, London, W.C.2
Tel: Whitehall 0568, 5 lines

quality malleable castings B·S·S309
EASILY MACHINEABLE
also
SOFT GREY IRON CASTINGS
for all trades

alfred.h MOULD & SONS LIMITED

Our metal is melted under strict metallurgical control in modern Rotary Furnaces and is annealed in up-to-date pulverised coal furnaces ensuring perfect dependability.

STAFFORD STREET · WALSALL · TEL: 3509

SOUTHERN REPRESENTATIVE:
G. P. SANDERSON, LTD.
SANDERSON HOUSE, NORFOLK SQ.
BRIGHTON 1.
PHONE: HOVE 71329.

LANCS, YORKS, CHESHIRE, SHROPSHIRE REPRESENTATIVE:
MALCOLM P. ROWE
PRUDENTIAL BUILDINGS, ST. PETERSGATE, STOCKPORT, CHESHIRE.
PHONE: STOCKPORT 5512.

Are these hands helping *you?*

Test and experimental work in P.J. laboratories, carried out in the hands of qualified paint chemists, is the basis of the expert Technical Advisory Service which is offered to all industrial paint users. The services of these skilled hands are directly available through personal contact with your P.J. technical representative.

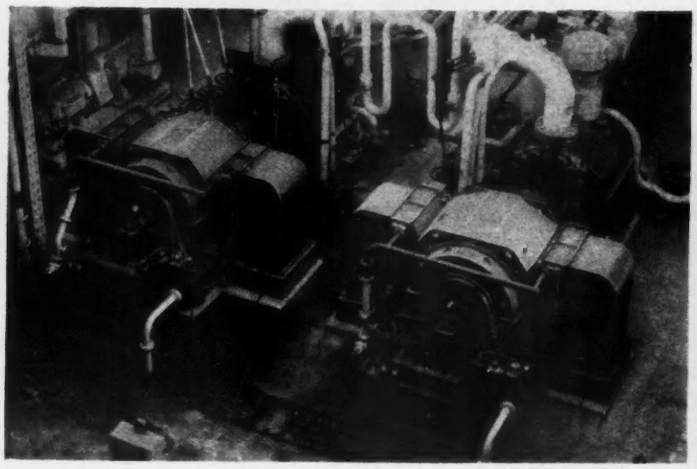
You can rely on

PINCHIN JOHNSON

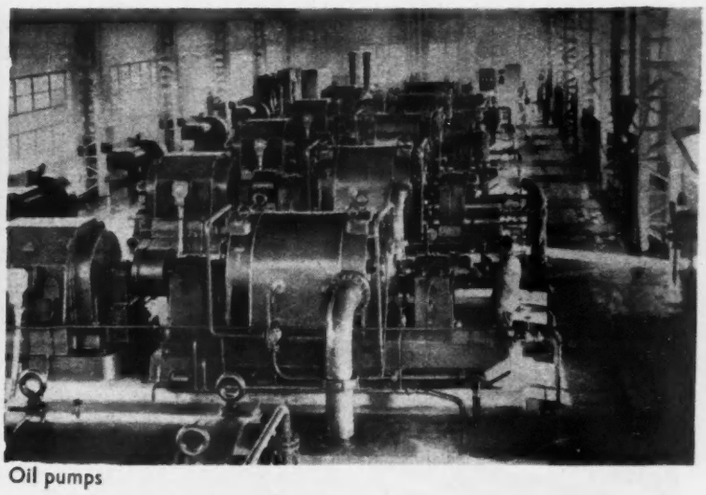
for Paint and Service

PINCHIN, JOHNSON & CO., 4 CARLTON GARDENS, S.W.1
Telephone: TRAfalgar 5600

BELFAST · BIRMINGHAM · BOOTLE · BRIGHTON · BRISTOL · GLASGOW
LEEDS · MANCHESTER · NEWCASTLE-ON-TYNE · SOUTHAMPTON

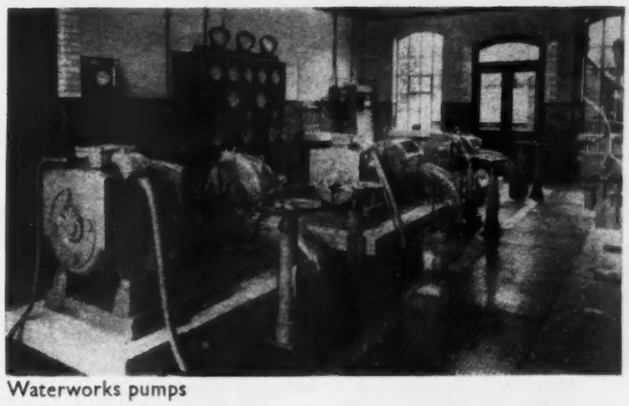


Boiler feed pumps

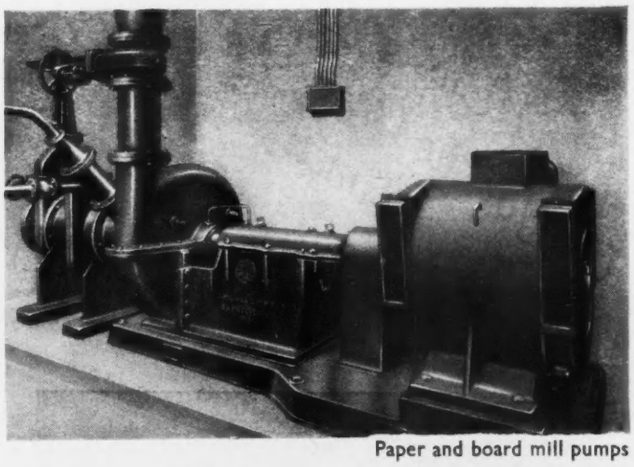


Oil pumps

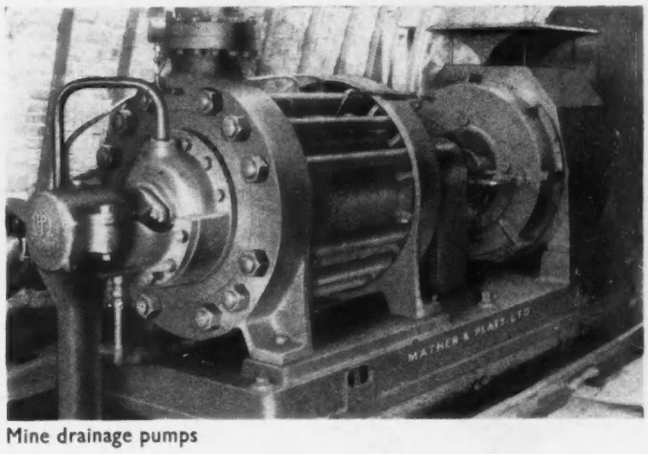
Pumping Sets



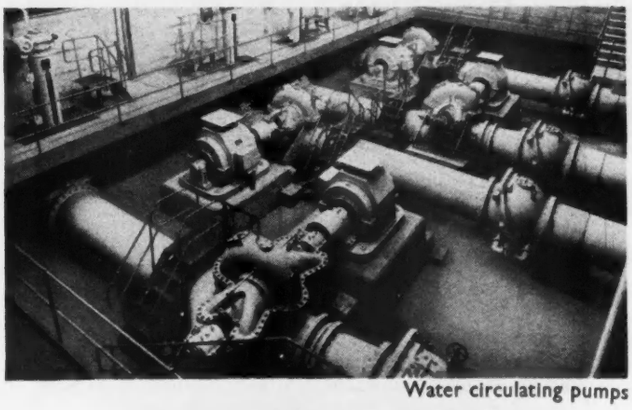
Waterworks pumps



Paper and board mill pumps



Mine drainage pumps



Water circulating pumps

for all industries and all services

Mather & Platt Ltd. specialise in the manufacture of motor-driven pumping sets for all duties. The illustrations show installations in some of the services and industries served by Mather & Platt pumps and motors.

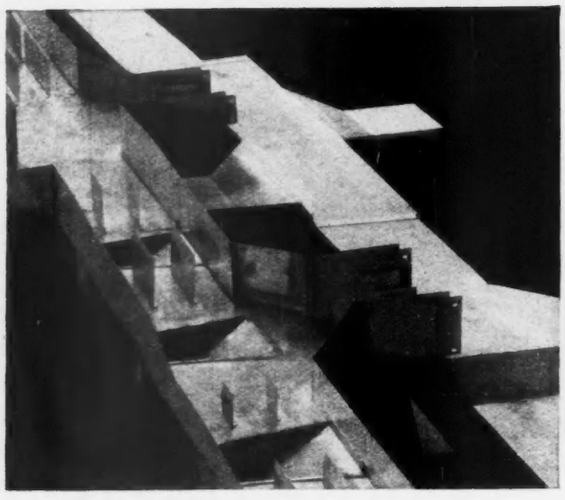
Mather & Platt LIMITED

PARK WORKS, MANCHESTER, 10.

Telephone : COLlyhurst 2321
Telegrams : MATHER, MANCHESTER

920

4½ miles of **BRABY** *Perforated Mild Steel Cable Trays and Supports supplied to* **Messrs. Pye Limited, Cambridge,** *for the* **Spadeadam Project, Carlisle,** *to the instructions of the main contractor, British Oxygen Wimpey Ltd, for the Chief Engineer, Ministry of Works.*



We also supplied the cable trunking for the control rooms at this important site. The photographs are views of parts of the trays, supports and trunking erected at our Works prior to dispatch.

ONE OF THE WIDE RANGE OF

BRABY

PRODUCTS

FREDERICK BRABY & COMPANY LIMITED

LONDON WORKS, THAMES ROAD, CRAYFORD, KENT. TELEPHONE: **CRAYFORD 26262**

OTHER FACTORIES AT: Havelock Works, Aintree, **Liverpool, 10.** TELEPHONE: Aintree 1721
Eclipse Works, Petershill Road, **Glasgow, N.** TELEPHONE: Springburn 5151
Ashton Gate Works, **Bristol, 3.** TELEPHONE: Bristol 64041. And **Falkirk**
OTHER OFFICES: 352-364 Euston Road, **London, N.W.1** (Head Office). TELEPHONE: EUSton 3456
110 Cannon Street, **London, E.C.4** (Export). TELEPHONE: MANsion House 6034
Queen's Buildings, 10 Royal Avenue, **Belfast.** TELEPHONE: 26509
Palace Street, **Plymouth.** TELEPHONE: 62261

AP 91

soot blowing

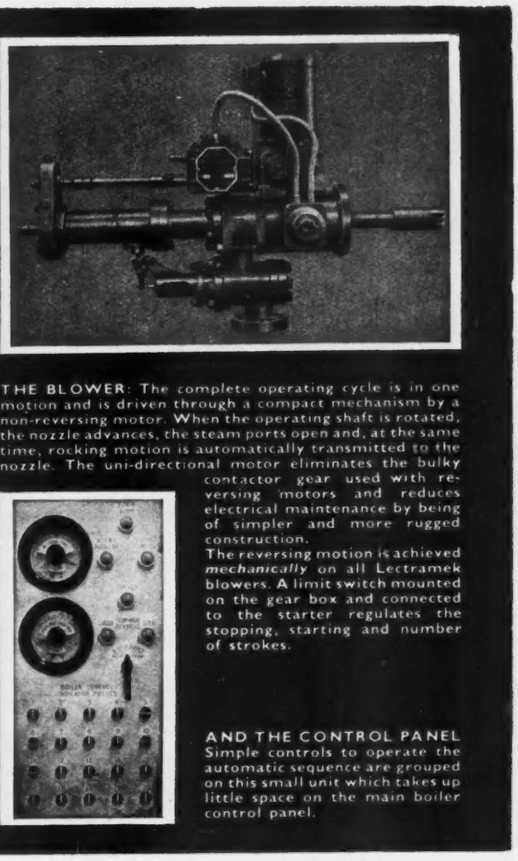
is a push-BUTTON job

with the NEW CLYDE system

UNIFIED LECTRAMEK CONTROL SYSTEM

most efficient yet devised.

Considerable savings in initial cost and valuable boiler room space have been achieved by this new system of electrical control which works in conjunction with the Clyde Lectramek Soot Blower* - the original blower employing a uni-directional motor. Control is exercised from a small panel which indicates all essential information to the operator.



THE BLOWER: The complete operating cycle is in one motion and is driven through a compact mechanism by a non-reversing motor. When the operating shaft is rotated, the nozzle advances, the steam ports open and, at the same time, rocking motion is automatically transmitted to the nozzle. The uni-directional motor eliminates the bulky contactor gear used with reversing motors and reduces electrical maintenance by being of simpler and more rugged construction.
The reversing motion is achieved *mechanically* on all Lectramek blowers. A limit switch mounted on the gear box and connected to the starter regulates the stopping, starting and number of strokes.

AND THE CONTROL PANEL
Simple controls to operate the automatic sequence are grouped on this small unit which takes up little space on the main boiler control panel.

CLYDE SOOT BLOWER EQUIPMENT

Further information is given in our publication No. CBL. 1954 which will be supplied on application.

CLYDE

*Over 5,000 blowers of this type in use all over the world

CLYDE BLOWERS LTD.
CLYDEBANK · SCOTLAND
Tel: Clydebank 2161/4
LONDON: 34 Victoria Street, London, S.W.1 Tel: ABBey 1847
LIVERPOOL: 7 Tithebarn Street, Tel: CENtral 5071

BY TEST—THE BEST

"PALNUTS"

the really safe locking washer

FITS ON TOP OF THE NUT

SPINS ON— STAYS LOCKED

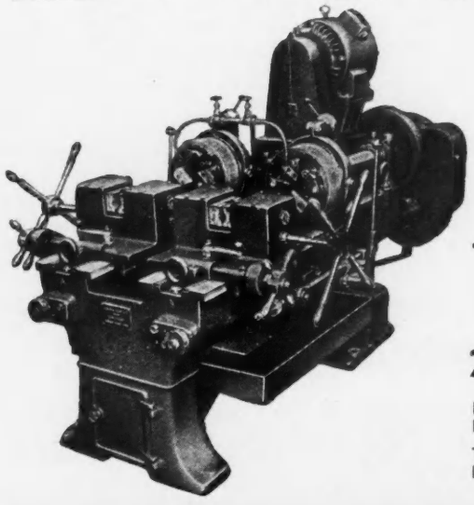
Send for details to:
THE PALNUT CO. LTD.
(Estd. 1919)
PALNUT WORKS,
3 ARTHUR STREET,
HOVE, 3, SUSSEX
Tel: HOVE 70427 Grams: PALNUT HOVE

Specify

MICHELL BEARINGS

AND MAKE SURE OF YOUR

THEY SET THE COURSE FOR RELIABILITY
FOR Turbine Thrusts, Pedestal Bearings, Hydro-Electric Installations, Motors, Generators, Paper Making and Extruding Machines, Pumps, Fans, Etc., Etc.
MICHELL BEARINGS LTD
SOUTH BENWELL
NEWCASTLE upon TYNE, 5
Telegrams: MICHBEARO Telephone: 3427



Double production!

with

HEAP'S

2½in. DOUBLE HEAD BOLT SCREWING MACHINE

Designed for really high output the HEAP'S Automatic 2½in. Bolt Screwing Machines will cut either right- or left-hand threads (or both at the same time).

The machine is fitted with our patent TANGENTIAL Die Heads, which open automatically when any predetermined length has been threaded. Capacity: Bolts up to 2¼in. dia., pipes up to 2in. dia., parallel or taper.

JOSHUA HEAP & Co LTD

ASHTON-UNDER-LYNE, ENGLAND

BIRD'S

GEARS & GEAR
CUTTING, PROFILE
GROUND GEARS,
COMPLETE
REDUCTION UNITS.

W. H. BIRD & SONS LTD
ST. PHILIPS, BRISTOL 2

Phone: Bristol 77033 · Grams: Oiseau Bristol.

GEARS Bristol

Stainless Steel 18/8

BOLTS · NUTS · SCREWS
WASHERS · RIVETS · COTTER PINS

MOST STANDARD SIZES

EX STOCK

FROM THE SPECIALISTS

G. F. BRIDGES LTD

SNOW HILL, BIRMINGHAM TEL: CENTRAL 3911—5 LINES

GFB

One minute of your precious time—
that's all it will take to fill in the coupon below. It will introduce you to valuable time-savings in production and finishing methods from the use of E.A.C. 'shaped-grain' flexible abrasives. These coated abrasives, made by the latest controlled automation techniques, incorporate every worthwhile advance in design and manufacture. In the wide range of E.A.C. belts, discs, sheets and special shapes there is sure to be, for any operation, one that cuts faster and wears longer than those you are now using.
The right abrasive can save you money, let *us* find it for you; send now for samples, specifications, prices of the best abrasive for any operation in your industry.

Please send your catalogue and price list of Metalworking coated abrasive materials to:

NAME .....
COMPANY .....
ADDRESS .....
.....
.....
A6/3

change now . . . to

EAC LIMITED

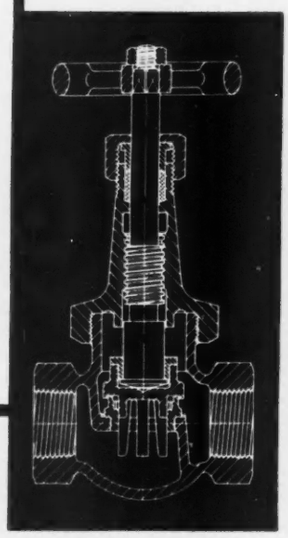
coated abrasives

ENGLISH ABRASIVES CORPORATION LTD
Marsh Lane, Tottenham, London N.17 Tel: Tottenham 5057
SUBSIDIARIES: Thos. Goldsworthy & Sons Ltd
The Helvetia Abrasive Co. Ltd
London Abrasives Ltd

D.1557

AT HIGH PRESSURES AND TEMPERATURES

the NEW Peglers steam stop valve 1028B is first in its class



Many unique design features, and manufacture to close limits, make this the most reliable valve of its class ever produced. The operational limit of 300 p.s.i. at 600°F is higher than the maximum required by B.S. 2060:1953. Renewable valves and seats are made in specially treated high quality stainless steel to ensure long life under the most exacting conditions.

- *Pressure tight joints. Ends screwed to B.S. 21*
- *Heavy bonnet reinforces body*
- *Circular seat supports for minimum flow resistance*
- *Expansion cavity prevents wire drawing on seat*
- *Skirt protects seat from solids in pipe line*
- *Alignment of spindle thrust maintained in service*
- *Large hexagons for simple servicing*
- *Available in a wide range of sizes*

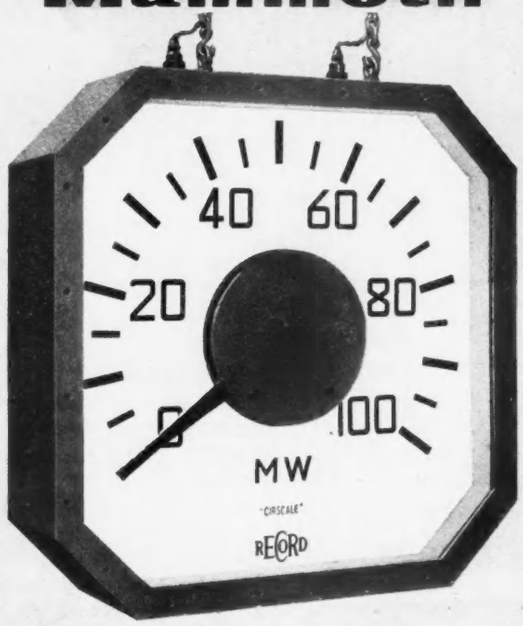
Peglers Limited
The name is the guarantee

For detailed information, please write for new leaflet

PEGLERS LIMITED · BELMONT WORKS · DONCASTER *Also at 28 Thorp Street · Birmingham, 5*
London Office and Warehouse : PRESTEX HOUSE · MARSHALSEA ROAD · S.E.1

TGA 8918

Mammoth



"Cirscale"

With a scale length of 5 feet, bold figures and internal illumination, this instrument can be read accurately at considerable distances. It complies fully with BSS 89/1954 and combines ample power with high sensitivity. It is suitable for indicating Amps, Milliamps, Volts, R.P.M. or Frequency, or any value which may be converted into one of these. Single or double sided models available

by RECORD

THE RECORD ELECTRICAL CO. LTD · 'CIRSCALE' WORKS · BROADHEATH · ALTRINCHAM · CHESHIRE

G 9238-6

HEAT TREATMENT

Capacity for case-hardening is now available in the most modern heat treatment plant in London

- Gas or pack carburising with full metallurgical control over all operations
- Gleason quenching press equipment for pieces up to 36" dia. plus wide experience in the control of distortion
- Flame-hardening of gears up to 10 ft. dia. with latest electronically controlled equipment

E.N.V. ENGINEERING COMPANY LIMITED

HYTHE ROAD, WILLESDEN, N.W.10

Telephone : LADbroke 3622 · 3 · 4 · 5 · 6

Exceptional Service in every Latitude

"10,000 HOURS — NO REPAIRS"
"The engine has been running a Mortar Mill 40 hours a week for five years; during that time there were never any repairs done, in fact the head was never off."
John McMillan & Son, Whitehouse, N. Ireland.

"AMAZED AT THEIR RELIABILITY"
"I have six of the 6-11 h.p. Armstrong Siddeley Air-Cooled engines; I must say I am more than satisfied with the engines and amazed at their reliability taking into account the very dusty air, sandstorms, and a temperature of around 123°F."
K. R. Gregory, Qatar, Persian Gulf.

"DONE A WONDERFUL JOB"
"The Armstrong Siddeley Air-Cooled engine has done a wonderful job; one set of rings and two valve grinds, and still uses no oil between changes."
V. Altman, Victoria, Australia.

The skill and experience associated with the production of the world-famous Armstrong Siddeley Aero Engines lies also behind the design of the Armstrong Siddeley diesel.

The manufacture of this range of air-cooled units has now passed to the Staines factory of Petters Ltd., whose sixty-three years of engine manufacturing experience will ensure continuity of quality.

The extension of the well-known Petter service organisation to the Armstrong Siddeley range will maintain the usefulness of these units wherever they are in service and for whatever purpose they are being used.

Three models: 6-11 b.h.p., 14-22 b.h.p., 20-33 b.h.p.

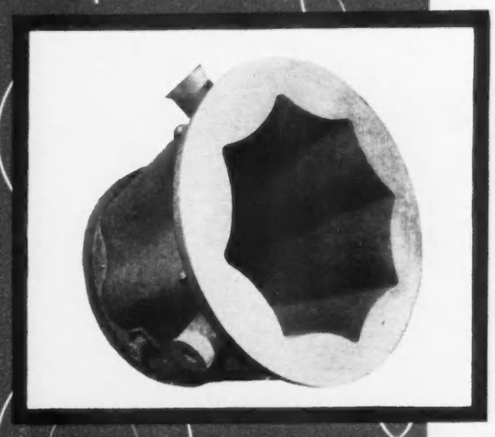
Leaflets are available on request.

ARMSTRONG SIDDELEY Air-Cooled Diesels

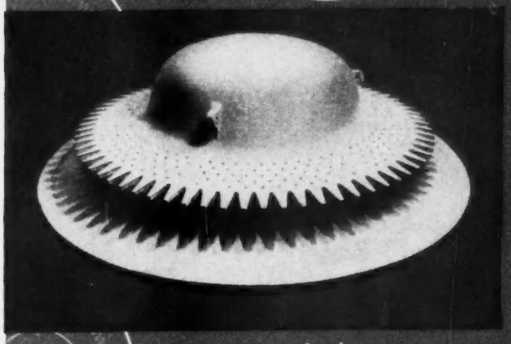
NOW MANUFACTURED BY PETTERS LTD

CAUSEWAY WORKS · STAINES · MIDDLESEX · ENGLAND *A Member of the Hawker Siddeley Group*

CPH/AS9/1

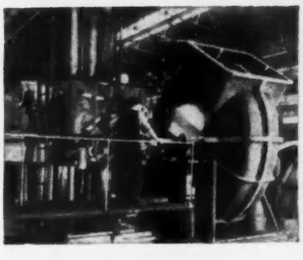


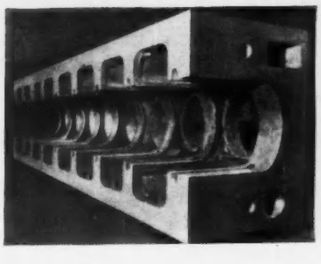
DISTINGTON
HEAVY
CASTINGS

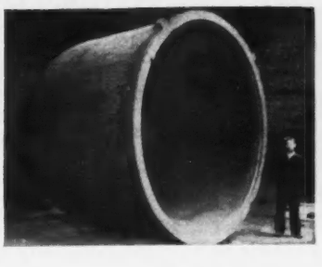


One of the largest foundries in the world is operated by Distington Engineering Company, which specialises in the production of heavy castings in hematite, grey and special irons.

DISTINGTON ENGINEERING
COMPANY LIMITED
Workington, Cumberland



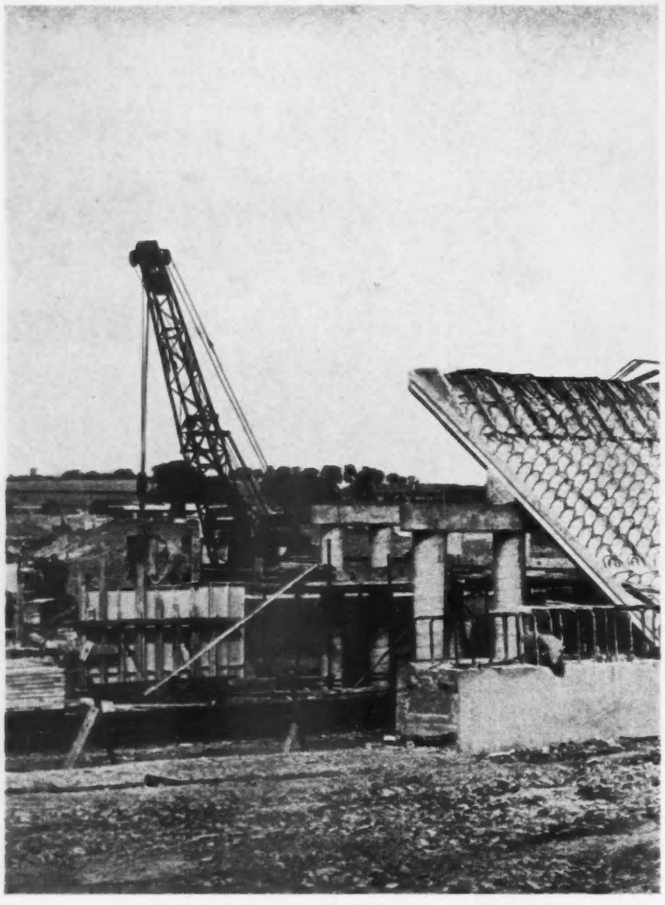




DISTINGTON

CA 12

NEAL
MOBILE CRANES



Type NS70—6 tons capacity

The new ***London-Yorkshire Motorway.***

Photograph by courtesy of Messrs. John Laing & Son and Thomas Fletcher & Co. Ltd.

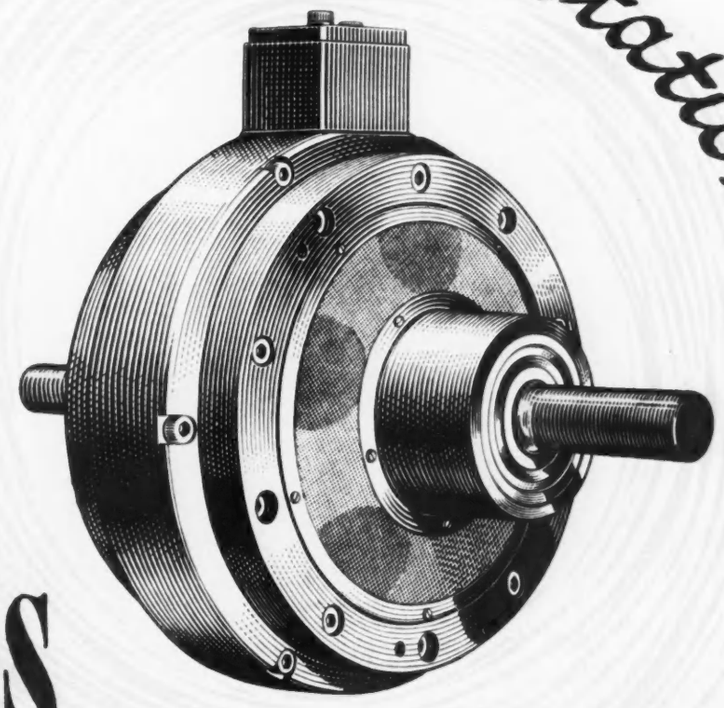
the name behind the best cranes *in any industry*

R. H. NEAL & COMPANY LIMITED

HEAD OFFICE · PLANT HOUSE · EALING · LONDON · W5

WORKS · GRANTHAM · LINCOLNSHIRE · ENGLAND

Revolution in Rotation



SMITHS Magnetic Particle COUPLING

which combines :—**the resilience of the hydraulic coupling and the positiveness of the frictional coupling.** It is revolutionary in that driving and driven elements are coupled by magnetically-activated particles. It has these advantages :—

Accurate torque control
No mechanical engagement and thus negligible wear
Accurate torque limiting slip on overload
Acts as brake or coupling in **either** direction
Perfectly smooth operation
No slip rings—excitation coil is stationary
Remote control at any distance
Dynamic and static coefficients of friction equal

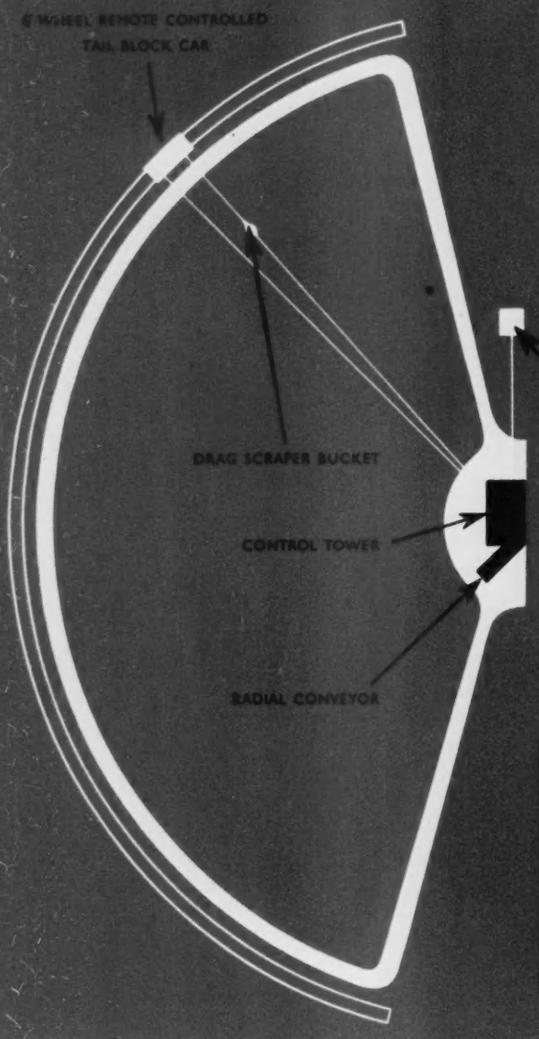
The range comprises eight standard units with torque capacities from ½ to 200 lb/ft.

SMITHS Magnetic Particle COUPLING is unique, its potentialities enormous. Let us advise you, therefore, how best to use it in your particular field

SMITHS **S. SMITH & SONS (ENGLAND) LTD.**

INDUSTRIAL PRODUCTS DEPARTMENT, WITNEY, OXON.

BEAUMONT DRAG SCRAPERS



The Beaumont Drag Scraper system for stocking out and reclaiming coal at the Central Electricity Generating Board's Goldington Power Station, is an important section of the complete Coal Handling Plant which includes wagon tipplers, gravity bucket and belt conveyors supplied by International Combustion Products Limited.

The stocking out and reclaiming tower.

Drag Scrapers can be effectively applied to almost any shape of store ground and they have the advantage of simple control of Scraper Bucket and tail car by one man housed in a weatherproof cabin, with clear visibility of all operations. Standard designs are available for light, medium and heavy duties.

IC

INTERNATIONAL COMBUSTION PRODUCTS LIMITED

Member of Atomic Power Constructions Ltd. One of the five British Nuclear Energy Groups

LONDON OFFICE: NINETEEN WOBURN PLACE, WC1. TELEPHONE: TERMINUS 2833
WORKS: DERBY

TGA/MH19

WELLMAN CRANES

Wellman 25-ton and 10-ton Electric Overhead Travelling Cranes specially equipped with creeping-speed hoisting gear.

Our products include every type of Electric Crane and Material Handling Equipment from the smallest Telphers to the largest Bridge-building Cranes and Transporters.

Wellman Cranes give constant service under the most severe conditions and are known throughout the world for their reliability.

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LTD

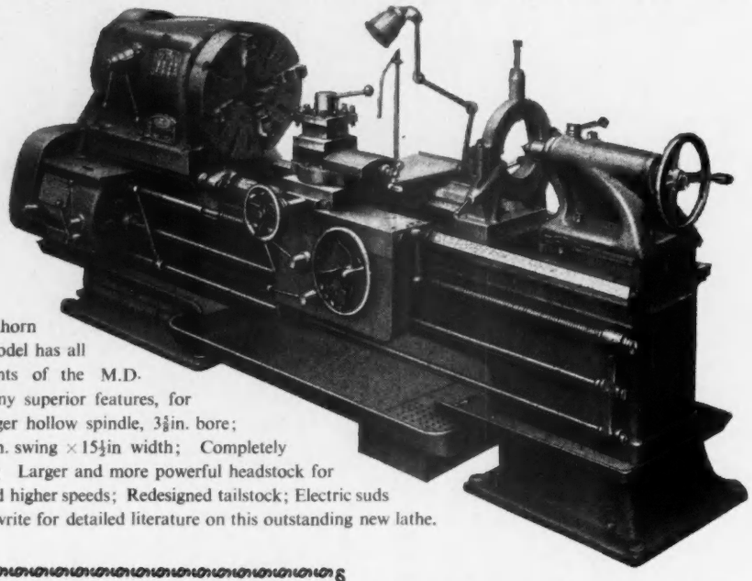
PARNELL HOUSE, WILTON ROAD, LONDON, S.W.1 WORKS: DARLASTON, South Staffs, & BELFAST.

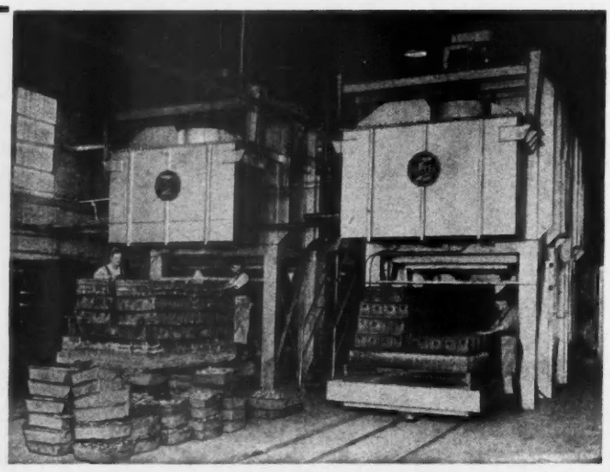
STEEL FRAME BUILDINGS
OF EVERY DESCRIPTION
Factories, Sheds, Mill Buildings, Foundries, Bungalows, Etc.
SPECIALITIES
Pit Headgear, Pumping Stations, Power Stations.
Bridgework and Riveted Work of all descriptions
BROWNLIE and MURRAY LTD.
POSSIL PARK, GLASGOW
LONDON: 32, QUEEN VICTORIA ST. E.C.4.

TRADE Smedley MARK
PAN GRINDING MILLS

REVOLVING OR STATIONARY PANS
PERFORATED OR SOLID BOTTOMS
OVER OR UNDER DRIVEN
Smedley Brothers. Ltd.,
Belper. Derbyshire.
Telephone: Belper 12

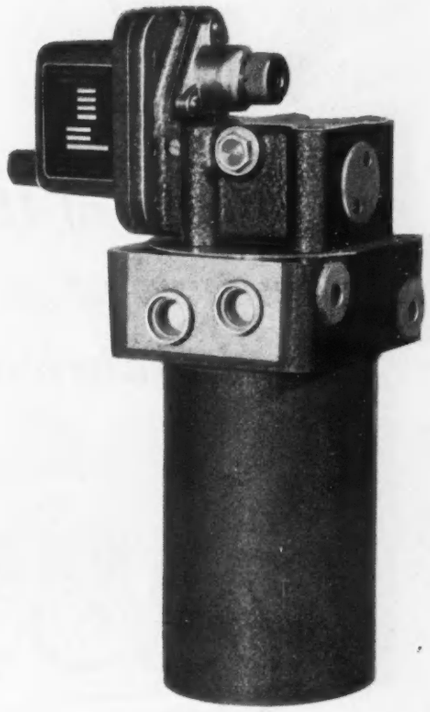
MICA
ESTABLISHED 1840
FOR
INSULATION
WATER GAUGES
ETC.
F. WIGGINS & SONS
9-11 TREDOWN RD., SYDENHAM, S.E.26
Tel: SYDenham 7660

IN A CLASS BY ITSELF
the new
CROWTHORN
10½" (21" SWING) H.D. MODEL CENTRE LATHE

The new Crowthorn 10½in. H.D. Model has all the good points of the M.D. Lathe plus many superior features, for example:—Larger hollow spindle, 3⅜in. bore; Larger gap, 36in. swing × 15½in width; Completely redesigned bed; Larger and more powerful headstock for heavier cuts and higher speeds; Redesigned tailstock; Electric suds pump. Please write for detailed literature on this outstanding new lathe.
1908 - 1958
fifty years of high class machine tool manufacture
Other famous models in the Crowthorn range include Centre Lathes from 7½in. to 20in. centres, 30in. and 36in. swing Boring and Facing Lathes, with square or hexagon turrets, combination Turret Lathes and 19½in. stroke Shaping Machines.
CROWTHORN ENGINEERING COMPANY LIMITED
REDDISH - STOCKPORT - ENGLAND
Phone: STOCKPORT 7271-2-3 Grams: 'CROWTOOL, REDDISH'
CROWTHORN
HIGH CLASS MACHINE TOOL MAKERS
CI 96.

MALLEABLE IRON CASTINGS
ANNEALED IN THE MOST MODERN GASEOUS DECARBURISING PLANT
Excellent Physical Properties
From:
PLATT MALLEABLE CASTINGS LTD.
CLIVE FOUNDRY . LEAMORE . WALSALL


THREE ESSENTIAL UNITS . . .

. . . *for an electro-hydraulic servo system*



Servo Valve and Filter assembled as one unit

1 **SERVO VALVE . . .**

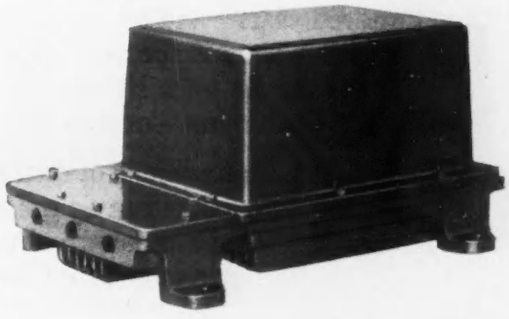
. . . specially designed for industrial applications. Available for 2.5, 5, 10 and 15 g.p.m. From 4 watt input to 10 h.p. output. Suitable for operation up to 3,000 lb. per square inch in temperature range −20°C to +100°C.

2 **MICRON FILTER UNIT . . .**

. . . for highly efficient filtration of particles of greater than 5 microns from industrial hydraulic systems. Available for use assembled to the Sperry servo valve or separately as a line filter.

3 **SERVO VALVE DRIVE AMPLIFIER . . .**

. . . to provide the link between the signalling elements of the servo loop, e.g., Sperry inductive pick-offs, synchros or tachos and the electro-hydraulic servo valve. Transistorised design, suitable for operation on 50 c.p.s. supply. Power gain—600 mA. differential current into a 20 ohm load with 20 mV. input, i.e., greater than 10^4. Designed to comply with *industrial* conditions.



Servo Valve Drive Amplifier

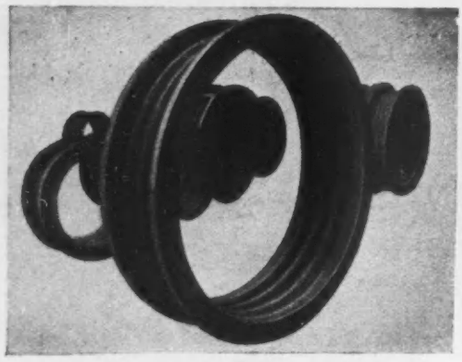
Write, call or telephone for more detailed information.

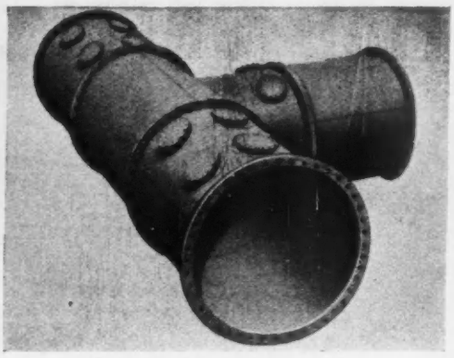
ENGINEERING, MARINE, WELDING & NUCLEAR ENERGY EXHIBITION
APRIL 16th TO 30th STAND No. 9 ROW F GRAND HALL

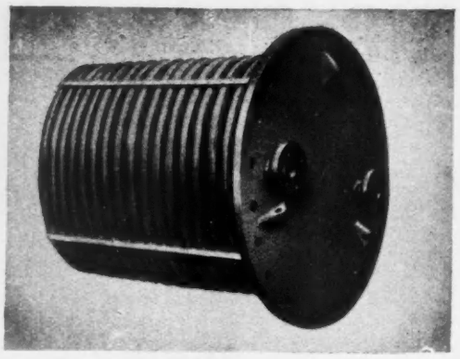
SPERRY

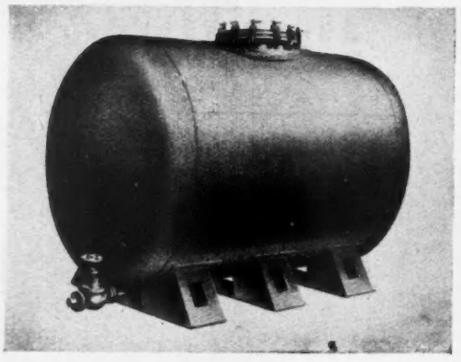
SPERRY GYROSCOPE COMPANY LIMITED INDUSTRIAL DIVISION

Great West Road, Brentford, Middlesex Telephone: EALing 6771, Telex: 23800









Clarks of Hull celebrate a century of progress in fabrication work

1859-1959

Now specialising in Stainless Steel, Mild Steel, Aluminium, etc.

Fabrication has come a long way in the last hundred years—and so have Clarks, whose new Fabrication Shop is specially, modernly equipped to handle work in stainless steel, mild steel and aluminium—as well as copper of course.

All the traditions of quality workmanship you would expect from a firm of such long and high standing are now combined with today's techniques at Clarks of Hull.

- **Metallic Arc Welding**
- **Argonaut and Argon-Arc Welding**
- **Stress-relieving and testing facilities**
- **Agents or representatives in all parts of the country**

Plate preparation bay—new Fabrication Shop

CLARK

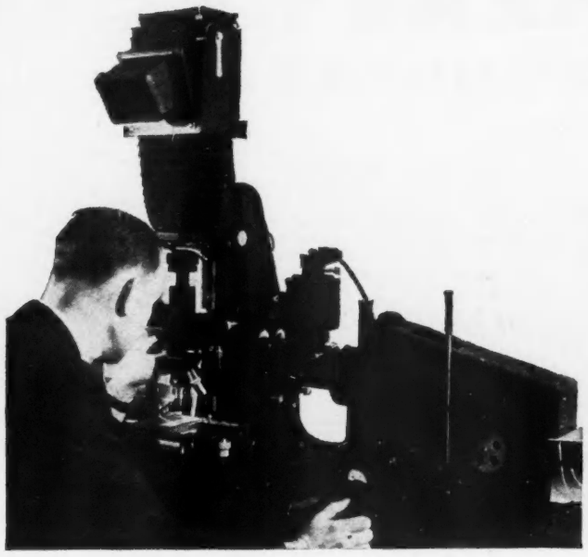
FOR EVERY TYPE OF WELDED FABRICATION

GEORGE CLARK & SONS (HULL) LIMITED
HAWTHORN AVENUE · HULL
Telephone: 37654 Telegrams:"Clark, Hull"

BCA

A MEMBER OF THE NEWMAN HENDER GROUP

In search of
THE RIGHT SOLUTION



FOR the efficient cleaning and degreasing of every known metal and alloy there is an "S.A.C." specific. For treatment in circumstances complicated by unusual conditions—the answer can be found by the "S.A.C." technicians. Consultation with "S.A.C." is the shortest, most economical way of finding the right solution for your metal cleaning problems. We have the equipment of today—the experience of many years.

PRODUCTION PROVED PRODUCTS

SUNBEAM
ANTI-CORROSIVES
LTD.

CENTRAL WORKS · CENTRAL AVENUE
WEST MOLESEY · SURREY

Telephone: Molesey 4484 (5 lines)
Telegrams: Sunanticor, East Molesey

Manufacturers of
STRIPALENE · FERROCLENE · ALOCLENE · FERROMEDE · BRAZOCLENE
(Regd. Trade Marks)

APPROVED BY ADMIRALTY, WAR OFFICE AND AIR MINISTRY

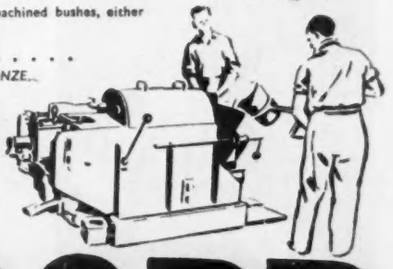
Spun Cast
OR CHILL CAST BRONZE

'LILY' BRAND CHILL CAST PHOSPHOR BRONZE
(CORED OR SOLID)

Produced to the very highest standards in a full range of sizes up to 10½" dia. Supplied as cast or rough machined within 0·010" of finished size.
Note, too, that we supply completely machined bushes, either plain or flanged.

SPUN CAST CORED BAR . . . . .
IN PHOSPHOR BRONZE, LEADED BRONZE, ALUMINIUM BRONZE, GUNMETAL, ETC.

The centrifugal process produces cored bar which is absolutely guaranteed to be free from defects, and we invite enquiries for Phosphor Bronze, Leaded Bronze, Gunmetal, Aluminium Bronze, Cupro Nickel, Copper, etc., either in bar form or rings, part or finished machined, etc. Full range of sizes up to 7" outside dia. by 3" bore.
Length up to 24".

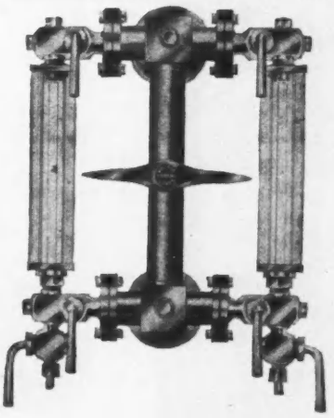


Rely on **CARR**

SPECIALISTS IN THE CASTING OF NON-FERROUS METALS

CHARLES CARR LIMITED

INCORPORATING THE NON-FERREOUS CASTING CO., (B'HAM) LTD
GROVE LANE SMETHWICK 40 · BIRMINGHAM
TELEPHONE - SMETHWICK 1231-2-3
LONDON OFFICE: 56 HOLBORN VIADUCT, LONDON, E.C.1. TELEPHONE: CITY 3826-3827



BOILER WATER GAUGES

- Three sided glass guards.
- Polished cast gunmetal throughout.
- Screwed and flanged versions in all sizes.
- Fully asbestos-packed for easy and reliable operation.
- Automatic shut-off valve in case of glass breakage.
- Range includes various designs for all pressures up to a maximum of 250 lb/in.²

ROBERT HARLOW
& SON LIMITED
HEATON NORRIS · STOCKPORT · CHESHIRE
TELEGRAMS: "HARLOW, STOCKPORT"
TELEPHONE: STO 3403/4/5.
LONDON OFFICE: 10 NORFOLK STREET, LONDON W.C.2. Telephone: COVent Garden 0315/6/7. Telegrams: "TUBENPIPE" - Phone - London.

CW5281

HEAVY DUTY SPANNERS

Precision Hand Tools are of paramount importance to the Engineering Industry. King Dick hand tools are precision made under carefully controlled conditions, and set a superlative standard in quality and design. From the largest Constructional Engineering Tools to the smallest B.A. Socket Set, King Dick inspection routines ensure the correct combination of selected steels, perfect balance and precision.

Send for illustrated catalogue giving complete range of King Dick Hand Tools.

A BINGDON **KING DICK**

PRECISION **HAND TOOLS**

ABINGDON KING DICK LTD., ABINGDON WORKS, TYSELEY, BIRMINGHAM 11, ENGLAND
R.E. 216

ENGINEERS!

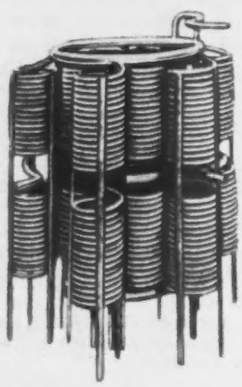
buy from

KIRKS-

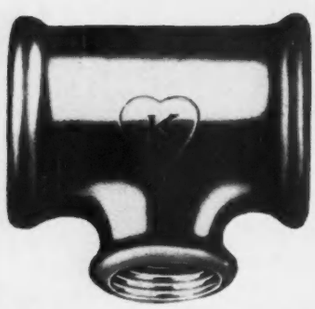
FORGED STEEL FLANGES TO BRITISH & AMERICAN STANDARDS

WELDING FITTINGS

FABRICATED PIPEWORK IN STEEL, STAINLESS STEEL AND COPPER



THE HEART OF RELIABILITY



MALLEABLE TUBE FITTINGS

...and you **BUY BRITISH!**

KIRK

& CO (TUBES) LTD

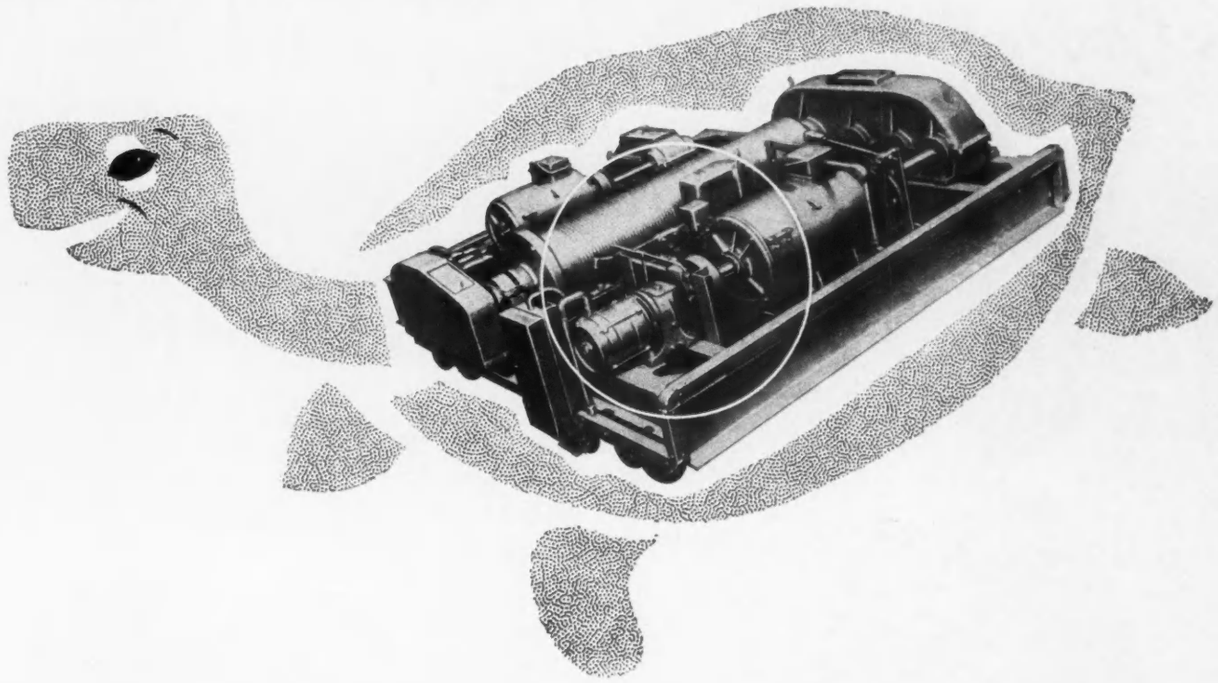
74 82 PARADISE ST., LONDON, S.E.16

BERMONDSEY 3156 7 8

WALSALL · MANCHESTER · PONTYCLUN

—as British as the Flag

slowly but surely . . .



Slomax Creep-Speed Control

This system was developed to meet the need for a controlled creeping speed for all motions of cranes on A.C. supply where precise slow-speeds are required.

The success of this well-tried system, proved under arduous conditions, lies in its extreme simplicity.

The device is entirely automatic and fool-proof.

The main motor is not energised when the creeping speed is in operation.

The operating circuits being electrically inter-locked, it is impossible for the main motor and the Slomax motor to operate simultaneously.

Slomax control permits an unlimited ratio between creeping and normal speeds, and whilst ten to one is usual, a ratio of fifty to one is not uncommon for specialised duties.

A further advantage is that where precise creeping speeds are required for specialised operations, the Slomax control will ensure a predetermined creeping speed, irrespective of the load on the hook.

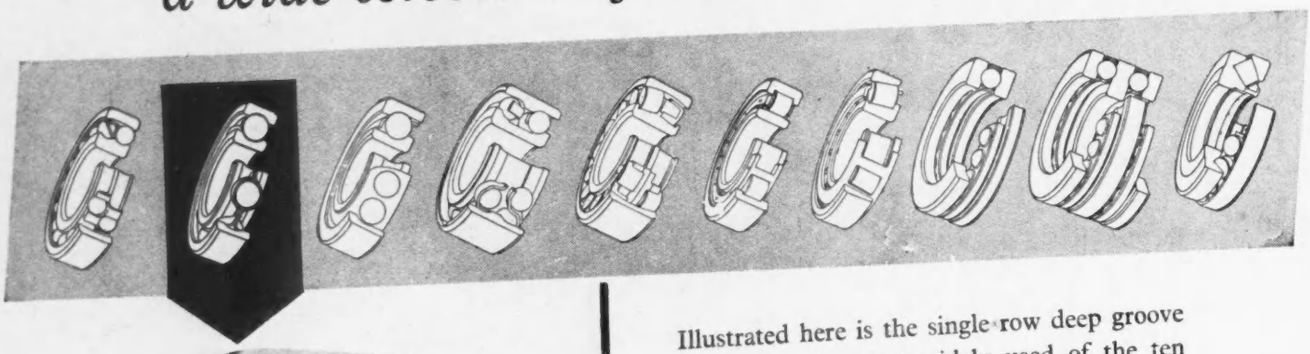
THE WHARTON CRANE & HOIST CO. LTD.

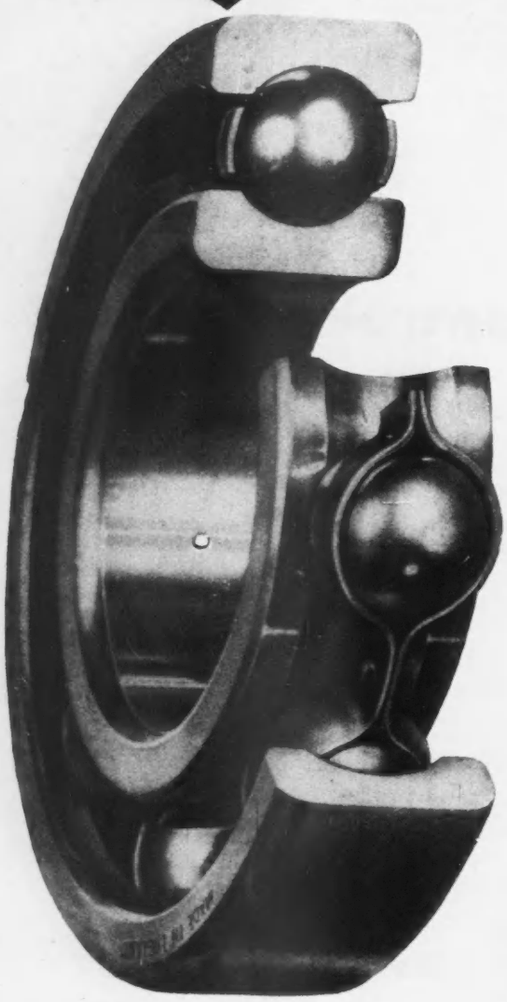
REDDISH STOCKPORT ENGLAND

Phone : Heaton Moor 2227. Grams : "Gallant, Manchester." Code : Western Union

LONDON: Lincoln House, 296/302 High Holborn W.C.I.	Phone: Chancery 7911.	Grams: Chancery 7911.
SCOTLAND: Fisher-Baxter & Co., 140 West George Street, Glasgow C.2.	Phone: Douglas 1061-2-3.	Grams: Fluorspar, Glasgow.
MIDLANDS: A. R. Holland & Son, 89 Cornwall Street, Birmingham 3.	Phone: Central 1457.	Grams: Central 1457, Birmingham.
SOUTH-WEST: R. C. Collins, 48 Westbourne Road, Penarth, Glamorgan.	Phone: Penarth 1527.	Grams: Penarth 1527.
NORTHERN COUNTIES: Fisher-Baxter & Co., 140 West George Street, Glasgow C. 2.	Phone: Douglas 1061-2-3.	Grams: Fluorspar, Glasgow.
NORTHERN IRELAND: General Engineering Products Ltd., 7/9 Great Patrick Street, Belfast.	Phone: Belfast 23743.	Grams: Belfast 23743.
EIRE or SOUTHERN IRELAND: Charles Nolan & Co., 2 Parker Hill, Lower Rathmines Road, Dublin.	Phone: Dublin 93510.	Grams: Dublin 93510.
CANADA: Marshall Equipment Co. Inc., P.O. Box 28, 61 Victoria Avenue, Dorval Station, P.Q.	Phone: Melrose 1-3528.	Grams: Marquipco, Montreal.

Only SKF can offer such a wide selection of British made bearings

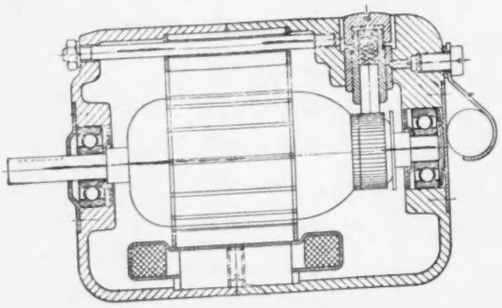




Illustrated here is the single row deep groove ball bearing, the most widely used of the ten variants of the four basic types of ball and roller bearing made by The Skefko Ball Bearing Co. Ltd.

The groove depth, ball size, and high degree of conformity between balls and tracks enables SKF single row deep groove ball bearings to deal with considerable thrust loads in addition to radial loads even at very high speeds.

A unique fund of technical information and experience lies behind the design of every SKF bearing—experience which is freely available to you whenever you have a bearing problem.



Bearing scheme for a small fan motor incorporating two single row deep groove ball bearings.

THE SKEFKO BALL BEARING COMPANY LIMITED · LUTON · BEDS

THE ONLY BRITISH MANUFACTURER OF ALL FOUR BASIC BEARING TYPES: BALL, CYLINDRICAL ROLLER, TAPER ROLLER AND SPHERICAL ROLLER

G 172

THE ENGINEER

No. 5380 MARCH 6, 1959 VOL. 207

THE NAVY ESTIMATES, 1959

A defence plan covering a period of five years leaves little scope for any important change of policy in the interim. Both in 1958 and this year the Defence White Papers and the Estimates have thus been, in the main, merely reports of progress made in implementing the plan—or rather half the plan. For they do not, and cannot, give any information—apart from generalities—of our progress in building up the Allied deterrent. This must be done in secret. They do, however, show what has been done during the past two years in re-equipping and modernising our Armed Forces whose personnel are to be reduced by 50 per cent, all recruited on a voluntary basis, by 1962. The recently published Defence White Paper, already discussed in these columns, sets out in some detail what has already been achieved in the Army and Royal Air Force. But the Estimates add much information of interest on the present state of the Royal Navy. The net Navy Estimates for 1959–60, at £370,700,000, are the highest sum Parliament has ever been asked to approve for the Navy in peacetime. But because of the supplementary Estimates to be presented this sum is £11,000,000 less than the amount expended on the Navy during the past year.

The First Lord's accompanying memorandum gives the incorrect impression that the naval building programme is all that could be desired. In addition to a large number of minesweepers and lesser craft, some ninety vessels—from aircraft carriers to submarines—will have joined the Fleet during the five years to December, 1960. They include, however, only six large fighting ships—three carriers and three cruisers—all laid down during the war and reconstructed and modernised. Much emphasis is laid on the prefabrication done on the structure of our four new guided missile destroyers, three of which are to be laid down this year. These vessels are to have both steam and gas turbine engines, the latter for boosting their speed and, when required, to enable them to get under way quickly in an emergency. But, in fact, they were authorised in the 1955 and 1956 Estimates. From the scale model of these ships at the Admiralty, they appear to be of about 5000 tons displacement—large destroyers, certainly, but without such good sea-keeping qualities as a cruiser. Nor are they large enough to be armed with surface-to-surface guided missiles or rockets. To suggest, as the First Lord did in his talk at the Admiralty, that their anti-aircraft defence missiles "Seaslug" and "Seacat" could be used offensively has little relation to modern requirements. In World War II, actions were fought between surface ships in the Pacific, using aircraft as their offensive weapon, at ranges of 200 miles and more.

The First Lord's memorandum still includes in the Fleet four cruisers and six destroyers which Parliament was recently informed are now on the disposal list. The number of our cruisers remaining—apart from the "Tiger," which has still to do her acceptance trials—is in reality ten and not fourteen. There is, indeed, little doubt that their number will soon be reduced to three—the minimum number required as replacements for the three "Tiger" class when refitting. A production order has been placed for the gas turbine engined Westland "Wessex" helicopter. The helicopter has a very important anti-submarine role to play. It can now be operated from almost any type of surface ship and cannot be detected by submerged submarines. Being immune from submarine attack, it is able to operate a sonar installation under ideal conditions, the Fleet thus gaining a greater defence in depth. The ordering of United States nuclear propulsion machinery—incidentally of the latest type—is to save about a year in the completion of our "Dreadnought" submarine. Rolls-Royce will have the complete plant for installing in a hull, to be built by Vickers, and as a model for their own plants in the future.

Meanwhile, eleven more "Porpoise" class, conventionally powered, submarines are to be in service by December, 1960. Their submerged speed and performance are a great improvement on the wartime submarines of any nation and they will be invaluable for anti-submarine training. The First Lord also reveals that our anti-submarine ships are to be equipped with anti-submarine torpedoes and with much improved detection and classification equipment. These torpedoes are, of course, the guided or "homing" weapons which United States anti-submarine vessels have had for some time. He gives, too, a satisfactory report of progress in the Fleet Air Arm. Squadrons are now being equipped with the interceptor fighter "Scimitar," and within a year the all-weather fighter "Sea Vixen" is expected to be in service with the Fleet. Finally, re-engagements are now again up to pre-war level. As one-fifth of our defence budget is earmarked for the deterrent, the First Lord is, indeed, to be congratulated on the Navy's progress. But we are still having to rely on an inadequate number of carriers and cruisers, all old, but reconstructed and modernised. If the Navy is to play an effective part in Britain's contribution to the free world, we must surely soon begin to build new ships, nuclear-propelled and armed with offensive as well as defensive guided missiles.

TECHNOLOGY AND TEACHERS

It was remarked by the late Sir Claude Gibb that of the three men who "had a profound effect on my make-up and approach to life," the first was "a great teacher," Sir Robert Chapman, professor of engineering at Adelaide University, who "taught me clarity of thought as a prime essential." The brilliant career of Sir Claude Gibb reminds us of the extent to which the success of our new colleges of technology—a success to be gauged only by their ultimate contribution to the national well-being—must depend upon the quality of the entrants, on the one hand, and of the teachers on the other. It is hardly necessary, having regard to the immemorial history of education, to stress the imperative need to employ such methods as will induce, within the student, a desire to propel himself. This calls for teachers who, like

Louis Agassiz a century ago in America, are bold enough to prescribe advanced and original work as factors in mental training, and human enough to " capture everyone by friendliness." It was this combination which gained for Agassiz the reputation of being " an incomparable teacher." An example of the other kind of teacher is recorded by St. Augustine, who tells us that his hatred of Greek—the use of which language he never acquired—was due to the harshness of the teacher, a man who enforced his lessons with savage terrors and punishments (*saevis terroribus ac poenis*). Very different were the methods of that great sixteenth century educationist John Cheke, who taught Greek (among other things) to King Edward VI. The influence of Cheke is said to have been paramount " partly because he gave his whole heart and mind to his pupil, for whom he was ambitious, watchful, sometimes critical and demanding, but never harshly so."* Cheke's methods were communicated to Roger Ascham, tutor to Queen Elizabeth I, who declared (in his book *The Schoolmaster*) that " No learning ought to be learnt with bondage. . . . Whatsoever the mind doth learn unwillingly, with fear, the same it doth quickly forget."

With his thought dwelling more on entrants than on teachers, Confucius, active about 500 years B.C., divided men into four classes : in the highest class he places those few men—Confucius calls them the " superior " men—whose knowledge is innate. The next highest class includes those men whose knowledge is acquired by study. After them follows that great mass of mankind which the philosopher regards as forming two categories—those who, being dull-witted yet strive to learn, those who, dull-witted, will make no effort to learn. Effort spent in the attempt to impart education to the ast category was wasted effort, the words attributed to Confucius being that " Refusal to instruct one who is competent to learn entails the waste of a man. Instruction of one who is incompetent to learn entails waste of words. The wise man is he who wastes neither men nor words." Reflection on the utterances of such as Confucius, Plato, St. Augustine, Thomas More, John Cheke, Roger Ascham and —in our own day—Louis Agassiz and George Saintsbury —renders nonsensical the idea of seeking, in education, to exalt the principle of equality regardless of the fact that there never has been and never will be equality of mental endowment. The supremely important thing is to cultivate, in the interest of the entire community, the flowering of that intellectual talent which, from whatever quarter it may be gathered, is a nation's most precious asset. To accomplish this is true socialism and we should remember that Confucius, while emphasising the disparity in natural endowments, declared that where there is education, distinction of class disappears.

Some time ago it was remarked by the Professor of Thermodynamics in the University of Oxford that : " Technologists are people who are educated at university level in the fundamentals of science and in their application to industry. Technicians, on the other hand, have only an *ad hoc* training in some special field of technology. Both groups are essential and are needed in much larger numbers. However, no number of technicians can replace a technologist." There is, however, a type of man who can be described neither as technologist nor as technician, but rather as an artist. Sir Harry Ricardo sketches an admirable example of this type of man in his account of the evolution of the piston aero-engine : " In every successful example it will be found that the actual designer of such an engine is neither a great scientist nor an expert mechanic, but an artist with an artist's temperament and intuitive genius, though none the less ready to appreciate and accept all the aid that the scientist and the practical mechanic can give him, and competent to blend his and their conflicting demands into a perfect picture. Such men are rare and in any one country, can be counted almost on the fingers of one hand. Without doubt the greatest of them all was the late Sir Henry Royce."†

This was written about 2500 years after the time of Confucius and it confirms—were confirmation needed—how the conception and rarity of the " innate " man remain the same throughout the ages. While we have the most clamant need to afford priority to the cultivation of those persons who possess that basic intelligence which can be enriched by study, the influence of one rare genius can be inestimable, though, like Sir Henry Royce, he may never have occupied a place in a technical college. As for research equipment, while its importance needs no emphasis, we must look rather to the intellectual power of the researcher. Let us not forget that the illustrious Tycho Brahe (1546–1601), without a telescope to help him, is said to have planned and catalogued 777 stars.

According to Bertrand Russell, " the main thing needed to make the world happy is intelligence." It is also the main thing needed in increasing the number of truly effective technologists and Bertrand Russell has asserted that " intelligence is a thing that can be fostered by known methods of education." The Government White Paper relating to colleges of technology does not omit to stress the importance of the quality of the teaching staff, which staff must, it is affirmed, consist of first-rate people well versed and interested in research. What will be still requisite, however, is that the teachers shall not be without some infusion of those qualities which were possessed by the distinguished practitioners already referred to. While the teacher cannot create the quality possessed by the innate man mentioned by Confucius, he should possess faculties enabling him to stimulate power and quality of thought in others, just as a catalyst has the property of accelerating the reaction or recombinations of substances. We may be thankful that there exists among potential technologists —as among all men worthy of the name—a desire for knowledge, in which connection we shall recall the words of that illustrious educationist Niccolò da Cusa in the place where he tells us how " Man desires to know more and more, he desires to know still more profoundly what he already knows, he desires to love more deeply that which he does love, and the wide world itself does not satisfy him, for his thirst for knowledge can never be quenched."

ON MAKING A FUSS OF GRADUATES

Many engineers in quite senior positions to-day must often wish they could be young all over again. For when they were educated sometime between the wars, nobody apart from papa seemed to bother very much where they were to get practical training after graduation or how they were to find employment. But see how different is the situation now ! Industrial firms are practically falling over themselves in their drive to attract graduates. The man expected by his professors to pass with honours is pestered during his last year with pamphlets and other literature attracting him to this, that, or the other industry, firm or research establishment ; and even the ordinary " pass " man need have no fears that entry upon apprenticeship may prove unduly difficult or that no job may

* See *The Last Tudor King*, by Hester W. Chapman.

† See *The High-Speed Internal-Combustion Engine*, by Sir Harry R. Ricardo. Fourth edition, page 301.

subsequently be available for him to take. The Ministry of Supply has now joined in this competition to acquire the graduate's services. Not content to rely upon such dry publications as " Scientists in the Civil Service : the Scientific Officer Class " (Civil Service Commission), or " The Scientific Civil Service Registration and Recruitment during the Reconstruction Period" (H.M.S.O.), or " Opportunity for Research " (Royal Aircraft Establishment), it has now issued a chatty and expensively produced brochure specially intended for the information of graduates about scientific careers in the Ministry of Supply. Copies are being sent to honours graduates in science as they qualify over the next few years. So eager is the Ministry that in a folder in the back cover are contained a form of " Application for Employment " and a reply paid envelope !

In these days, it will be observed, the whole matter of getting a job is made quite simple for the graduate. But between the wars few firms or organisations thought it worth while to make such a fuss of young graduates. Off-hand, we can, indeed, think only of one which was at that time pioneering along these lines. Many a high executive to-day, particularly if he was unfortunate enough to complete his training in the early thirties, had, instead, the sad, demoralising experience of being turned down for job after job. There was no question of choosing what kind of engineering work he was to do. He thankfully grabbed and held on to whatever job came his way ! The young man who had dreamed of successes in research found himself a maintenance engineer in a gasworks ; the " born " designer (in his own estimation) sold marine pumps ; instead of running a boiler shop (as he had hoped) a youngster found himself testing diesel engines ! How many of them, now grown older in " gas," in " sales," or in " diesels," would, we wonder, have done any better or worse, if they had been allowed to choose for themselves ? We wonder. For how many of those who have just graduated have any really true appreciation either of their own qualities or of those demanded in particular careers ? Moreover, for the great majority, we doubt whether it matters very much, within limits, what kind of engineering job they do. A designer, for example, is likely to prove good, bad or indifferent whatever he designs, whether it be diesels, steam turbines, machine tools, dams, roads, computers or household ironmongery. Moreover, unless he is, indeed, really talented and utterly determined to do one chosen kind of job, a young man will take, we suggest, as much interest and do just as well or ill in design, on the sales side, in maintenance, in the production shop, or in research! Probably he depends for his happiness more upon his finding a job amongst congenial companions than upon the precise nature of the work itself. Few middle-aged or older engineers, despite their early loss of youthful dreams, would, we think, choose to have had things turn out very differently from what they did. Perhaps had they been allowed their first choices they would by now have reached the very top positions. More probably not ; and, any way, how many people really want the topmost positions ? The majority find it a good deal more comfortable and a great deal less worrying just a bit lower down !

PRESERVING A FEN PUMPING ENGINE

The preservation of historic engines and other examples of the skill and craftsmanship of engineers of former days is a subject which is often brought to our notice. Never do we hear about such engineering relics without some feeling of regret that the facilities for the preservation of even the worthiest of them are severely restricted. But that regret is in a measure mitigated by our admiration for the enthusiasts who use their best endeavours to ensure that the outstanding works of engineers of the past are not allowed to fall into a state of complete decay. Endeavours of this kind have been actively encouraged for more than thirty years by the Newcomen Society. The society's energy, we are glad to say, is unabated. This week it has announced its sponsorship of the Stretham Engine Preservation Trust which has been established to save from destruction a single-cylinder condensing beam engine of 60 nominal horsepower, which, together with a 30ft diameter scoop wheel, was installed at Stretham, in the Fens near Ely, in 1831. Prior to that date, the drainage of the district had been effected by five windmill-driven scoop wheels, or wind pumps as they were called. But the water levels were falling and the wind pumps could not cope with the higher lifts ; nor, of course, could they be relied upon to pump at all unless sufficient wind was blowing ! The Stretham engine, which was built by the Butterley Company, is the sole remaining example of the first introduction of steam pumping to the Fens, a step which saved many thousands of fertile acres from inundation. The newly-formed trust has been granted a lease of the engine house, with the engine and scoop wheel, for a term of twenty-five years at a nominal rent. It is setting out to raise at least £2000 in order to maintain the buildings and their historic contents in good order for all who wish to do so, to see. The Stretham beam engine and scoop wheel are not merely a portion of the Fen drainage equipment that is no longer required. They stand, in their original setting in a remote part of East Anglia, as an excellent example of British technological skill. The Stretham Engine Preservation Trust deserves success in the task upon which it has started.

The Engineer—100 Years Ago (MARCH 4, 1859)

" THE SALTASH BRIDGE "

" The great work on which Mr. Brunel has been so long engaged at Saltash is at last finished. The directors of the Cornwall Railway passed over the bridge on Tuesday, the 22nd ult., and locomotives will run over it during the month, so that trains will run direct from Plymouth to Truro, 293 miles from London. The construction of this bridge upon any of the usual plans would have been a work of great difficulty ; as it is, the means employed have rendered its execution simple and comparatively easy . . . .

" The main spans are formed of arched elliptical tubes, from which the roadway is suspended by suspension chains and trussing. Each span is a bow-string girder, with the string relaxed, and receiving its tension directly from the load instead of through the bow. With all the points of strain in their exact position, the distribution of the load is very beautiful, and the system is, perhaps, as good as that of a level truss containing the same quantity of material. The spans, when loaded to a strain somewhat greater than that of the ballasted roadway, together with that of a continuous load of locomotives, deflected 7 in., from which they gradually returned after the load was taken off. Besides the main openings, there are seventeen land spans, making the entire length, 2,240 ft. The latter are formed by boiler-plate girders, resting on double columns of masonry.

" Whatever may be its merits as a work of engineering, the Saltash Bridge unquestionably ranks among the greatest structures of its kind. In magnitude, and perhaps in real grandeur, it considerably surpasses the Britannia Bridge, itself the greatest single engineering work in the world at the time of its construction."

Shape Factors and Functions in Rubber Engineering

By A. R. PAYNE, B.Sc., A.Inst.P.*

No. II—(*Concluded from page* 333, *February* 27)

This article† describes experiments to determine the form of the stress/strain relationships in compression for flat rubber pads of circular, rectangular, and square cross sections as well as pads of circular cross section with a central hole, under static and dynamic conditions and under bonded or lubricated conditions. The effect of fillers in the rubber composition on these relationships is discussed. Now, the static and dynamic stress/strain relationships for a rubber mounting deformed in shear are considered, and the experimental results shown to be in conformity with the theory derived from classical elasticity theory. The shape function and shape factor of a shear mounting are discussed. From a combination of the shape functions in shear and in compression, a theoretical expression for the stress/strain relationship for a combined shear and compression mounting is derived which agrees well with experiment.

PART II : SHEAR

RIVLIN (1948) has pointed out that a simple shear cannot be maintained by the application of constraints merely to the end faces of the rubber being deformed. If constraints are applied to the end faces of a rubber so that one face can move relative to the other, but only in a plane parallel to and at a perpendicular distance from the plane of the other (as in normal shear mountings), then the resulting deformation is not a simple shear but a combination of shearing and bending. This problem is similar to that encountered in the bending of a beam loaded at one end and has been solved by Saunders (1948) and Rivlin and Saunders (1949), who treated the deformation at any cross section as the superposition of the displacements due to simple shear and to bending under the action of the bending moment at that cross section. Fig. 18 shows the condition found in the deformation of a shear mounting of length l and radius r under a small static load. The displacement of the end of the sample

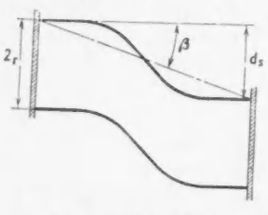


Fig. 18—To illustrate combined shearing and bending

perpendicular to its length is d_s and the two end faces remain parallel and at a constant distance apart. The deflection X_b due to bending is given by Southwell (1944).

$$X_b = Fl^3/12EaK^2 \quad . \quad . \quad . \quad (32)$$

where F is the shear load, E is Young's modulus of the material, a the cross-sectional area of the rubber, and K the radius of gyration of the cross section about the neutral axis of bending. The deflection X_s due to shearing will be given by

$$X_s = Fl/aG \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

where G is the modulus of rigidity. Since the total displacement d_s is regarded as the superposition of the displacements due to bending and shearing, then

$$d_s = X_s + X_b = Fl(1 + l^2/36K^2) \quad . \quad . \quad (34)$$

If the total deformation is regarded as simple shear, then up to d_s/l of 0·2 or more, the stress/strain relationship is approximately linear and the total deformation is defined by equation (35) where G_A is the apparent shear modulus and F/a is the shearing stress ;

$$F/a = G_A d_s/l \quad . \quad . \quad . \quad . \quad . \quad (35)$$

From equations (34) and (35) the true and the apparent shear moduli are connected by the relation,

$$G_A = G/(1 + l^2/36K^2) \quad . \quad . \quad (36)$$

Since $K = r/2$ for a circular cross-section flat pad type of mounting, where r is the radius, then equation (36) yields

$$G_A = G/(1 + l^2/9r^2) \quad . \quad . \quad (37)$$

Equations (35), (36) and (37) yield equations of the form

$$F = aGd_s/l(1 + l^2/9r^2) \text{ for cylinders} \quad . \quad (38)$$

and

$$F = aGd_s/l(1 + l^2/36K^2) \text{ in general} \quad . \quad (39)$$

The above equations relate to the static case, but in dynamic applications they require modification to allow for the effect of both frequency and temperature on the shear modulus, i.e. equation (37) becomes

$$G_{DA} = G_D/(1 + l^2/9r^2) \quad . \quad . \quad . \quad . \quad (40)$$

where G_{DA} is the effective dynamic shear modulus and G_D the true dynamic shear modulus.

The shape function is obtained from equations (38) and (39) as the ratio of F/G. Thus, for cylinders, the shape function is :

$$a \, . \, l/(1 + l^2/9r^2) \, . \, d_s/l$$

and the shape factor δ is defined as the radius/height, i.e. r/l. It is seen that shape factor defines the geometry of the mounting and appears in the expression for shape function, which is a composite expression involving strain, area, height and shape factor.

Fig. 19 plots the dynamic shear modulus G_{DA} for a pure gum natural rubber mix against δ, the shape factor. The theoretical curve in Fig. 19 is given by the relation :

$$G_{DA} = 63/(1 + 1/9\delta^2)$$

where

$$G_D \text{ is } 63{\cdot}0 \text{ lb per square inch} \quad . \quad (41)$$

It is seen that the experimental points fall very near the theoretical curve and that

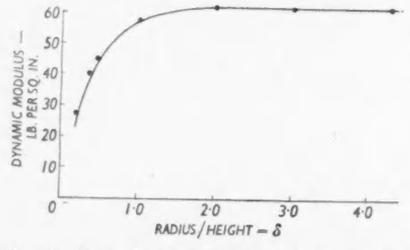


Fig. 19—Dynamic shear modulus G_{DA} versus δ. Theoretical curve $G_{DA} = 63/(1 + 1/9\delta^2)$. Experimental points

shape has only a considerable effect for δ's less than unity ; for δ's above this value the results are as expected from simple shear considerations.

The dynamic shear modulus results of De Meij and Van Amerongen (1954) show the same form of behaviour as in Fig. 19 and an analysis of their results shows that equation (37) holds true. Their results are not reproduced in this paper as they are similar to those shown in Fig. 19, except for the value of the dynamic rigidity modulus G_D.

In practice it can be seen that if pure simple shear is required, then for cylindrical pieces, for example, the ratio length/radius should not exceed 0·5. For larger values bending effects become important. At very large values, when the displacement is of the same order as the radius of the sample, it seems likely that the effects of simple extension may become more important than the effect of either shearing or bending.

Conclusion

From a classical treatment of the bending and shearing components of a shear mounting, the dynamic and static stress/strain relationships can be adequately described by equation (39) for static deformations, or (38) for the special case of cylinders, whilst equation (40) gives the dynamic modulus G_D applicable to the deformation of cylinders.

Notation.

A, A_1, A_2—Material constants, dimensionless.
B, B_1—Material constants, dimensionless.
C—Spring constant, pound per inch.
E—Apparent Young's modulus, pound per square inch or dyne per square centimetre.
E_D—Apparent dynamic Young's modulus, pound per square inch or dyne per square centimetre.
E_s—Real Young's modulus, pound per square inch or dyne per square centimetre.
F_1—Force on one spring, pound, Part III of paper.
F—Shear load, pound, in Part II and III of paper.
F_T—Total imposed force, pounds.
G—Shear or rigidity modulus, pound per square inch or dyne per square centimetre.
G_A—Apparent shear modulus, pound per square inch or dyne per square centimetre.
G^*—Complex dynamic shear modulus, pound per square inch or dyne per square centimetre.
G', G_D—Real part of the dynamic shear modulus, pound per square inch or dyne per square centimetre.
G''—Imaginary part of dynamic shear modulus, pound per square inch or dyne per square centimetre.
G_{DA}—Apparent dynamic shear modulus, pound per square inch or dyne per square centimetre.
G_U—Shear modulus of non-filler loaded rubber, pound per square inch or dyne per square centimetre.
G_F—Shear modulus of filler loaded rubber, pound per square inch or dyne per square centimetre.
H—Dynamic strain, dimensionless.
K—Radius of gyration.
P—Compressive load, pounds.
X_b—Bending displacement, inches or centimetres.
X_s—Shearing displacement, inches or centimetres.
a—Cross-sectional area, square inches or square centimetres.
b—Breadth of pad, inches or centimetres.
d—Vertical displacement of spring.
d_c—Compressive displacement, inches or centimetres.
d_s—Shearing displacement, inches or centimetres.
e_h—Strain in the height direction, dimensionless.
e_b—Strain in the breadth direction, dimensionless.
e_l—Strain in the length direction, dimensionless.
f—Stress.
f_c—Stress, compression, pound per square inch or dyne per square centimetre.
f_{cu}—Stress, compression of non-filler loaded rubber, pound per square inch or dyne per square centimetre.
f_{cF}—Stress, compression of filler loaded rubber, pound per square inch or dyne per square centimetre.
h—Height of pad, inches or centimetres.
k—Material constant, dimensionless.
l—Length of pad, inches or centimetres.
n—Material constant, dimensionless.
r, r_1, r_2—Radius ; r_1 internal, r_2 external, inches or centimetres.
Φ—A shape function, dimensionless.
α—Angle of shear.
ϕ—Phase angle.
δ—A shape factor, dimensionless.
λ, λ_0—Ratio of compressed height of pad to initial height, (λ_0 . static precompression), dimensionless.

* Senior Scientific Officer, Research Association of British Rubber Manufacturers, Shawbury, Shrewsbury, Shropshire.

† R.A.B.R.M. Research Report No. 84, "Dynamic Properties of Vulcanised Rubber : 5."

PART III : COMBINED SHEAR AND COMPRESSION

Introduction

The use of rubber in shear has an overwhelming advantage in insulating from low-frequency vibrations, due to the large deflections obtained, whilst rubber under compression is ideal for energy absorption and its use has been widely developed for shock absorbers. This depends, of course, on the non-linear stress/strain curve, which opposes the motion with increasing force as deflection increases. In fact, an examination of typical mountings will reveal that in most successful applications, rubber is employed in a combination of shear and compression, thus making use of the characteristics of both as fully as possible. Shock loads and static loads such as direct mechanical, gravity, acceleration, will usually be taken in compression, while vibratory loads (such as alternating mechanical) will be taken in shear.

A very common form of mounting, especially for cars and engine mounts, is of

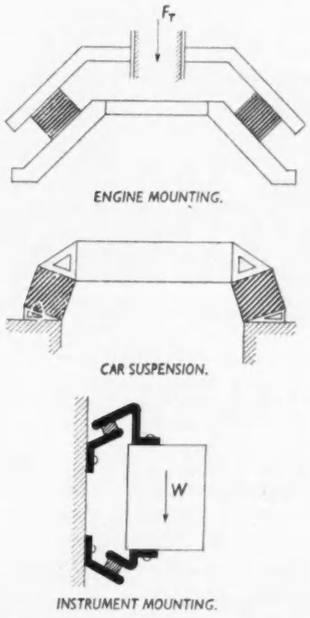


Fig. 20—Illustrating several types of suspension using mountings simultaneously sheared and compressed

the type shown in Fig. 20, where the rubber is deformed in both shear and in compression. It is the purpose of this section to derive a mathematical stress/strain relationship for various angles at which the rubber is mounted with respect to the direction of the imposed force. The rubber can be of any right prismatic or cylindrical form where the compressing faces are parallel to each other, e.g. circular, square or rectangular cross-section flat pad, but only the circular pad will be considered here with an indication of the effect on the stress/strain curves of various shapes and sizes.

Calculation of the Spring Characteristics of the Systems

Fig. 20 shows the circular pads set obliquely, the pads being joined by a bridge upon which is applied the total impressed force F_T.

In order to simplify the analysis, consider each pad separately, i.e.

$$F_T=2F_1 \quad . \quad . \quad . \quad . \quad . \quad (42)$$

where F_1 is the force on one spring, and the spring constant is thus $c=F_1/d$ where d is the vertical displacement of the spring.

As the system is symmetrical, the directions of the impressed force and of the subsequent deformation are the same, and the deformation of the pad is the result of a force N acting horizontally outwards, see Fig. 21. The resultant force is F^1, the

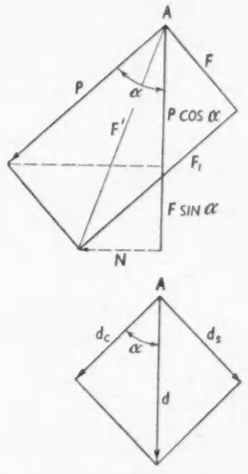


Fig. 21—Force and displacement vectors

resultant of vectors F_1 and N, but it can also be regarded as the result of vector components F and P where F is the shear force and P the compressive force. Similarly, d the vertical displacement, is the resultant of displacements d_s (shear displacement) and d_c (the compression displacement).

It is seen from Fig. 21 that as α, the angle at which the central axis of the spring is set to the direction of the imposed force, changes, then the resultant stress/strain relationship will also change. Considering A in Fig. 21 as the point of application of the forces F_1, then the following relationships hold :

$$F_1=F\sin\alpha+P\cos\alpha \quad . \quad . \quad . \quad (43)$$

$$d_s=d\sin\alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad (44)$$

$$d_c=d\cos\alpha \quad . \quad . \quad . \quad . \quad . \quad . \quad (45)$$

Shear Component.—The theory of the shear component has been derived in the second part of this paper ; equations (38) and (39) relate the shear force component F of the resultant force F^1 to the shear displacement d_s.

Compression Component.—Equation (4) for compressive stress shows that for a circular pad of cross-sectional area a, the compressive force P is given by :

$$P=Ga(\lambda-\lambda^{-2})(A+B\delta^2) \quad . \quad . \quad . \quad (46)$$

where

$$\lambda=1-d_c/l=1-(d\cos\alpha)/l.$$

Combined Stressing.—From equations (39) (42–46) it can be shown that the total force F_T is given by :

$$F_T=2aG[d\sin^2\alpha/l(1+l^2/36K^2)+(\lambda-\lambda^{-2})(A+B\delta^2)\cos\alpha] \quad . \quad . \quad . \quad . \quad . \quad (47)$$

where

$$\lambda=1-d_c/l=1-(d\cos\alpha)/l.$$

The terms inside the square brackets are purely geometrical, and for a circular flat pad of radius/height ratio of one, i.e. $r/l=1\cdot0$, $K=r/2$, $A=1\cdot0$, $B=0\cdot413$, $\delta=1\cdot0$, equation (47) reduces to

$$F_T=2aG[(0\cdot9d\sin^2\alpha)/l \; . \; +(\lambda-\lambda^{-2})1\cdot413\cos\alpha] \quad . \quad . \quad . \quad . \quad . \quad . \quad (48)$$

The general expression, equation (47), contains two sets of terms, which take into account the shape factor effects in shear and compression respectively, and it separates the purely geometrical properties from the rubber property, G, the rigidity modulus. When $\alpha=0$, the characteristic curve for F_T against displacement for pure compression stressing is obtained, and when $\alpha=90$ deg. that for shear stressing. From equation (47) the shape function for a cylinder which is defined as F_T/G, is :

$$2a[d\sin^2\alpha/l(1+1/9\delta^2)+(\lambda-\lambda^{-2})(1+0\cdot413\delta^2)\cos\alpha].$$

Experimental Verification

Circular cross-section flat pads of a pure gum rubber mix were prepared with a radius/height ratio of unity and bonded into hardwood jigs of the type shown in Fig. 22. The

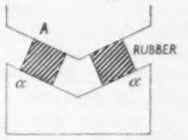


Fig. 22—Illustration of the type of jig used

completed assembly was then placed between the anvils of a dynamic testing machine (Payne, 1956, *b*) and strained, the forces being measured by means of a transducer type of differential transformer, set into a metal proof ring. (Payne and Smith 1956). The forces were recorded sixty seconds after each increment of strain. No hysteresis was observed in cyclic repetition for this mix.

The force/deflection curves for angles (α) of 0 deg., 15 deg., 30 deg., 45 deg., 60 deg., 75 deg. and 90 deg. are shown in Fig. 23.

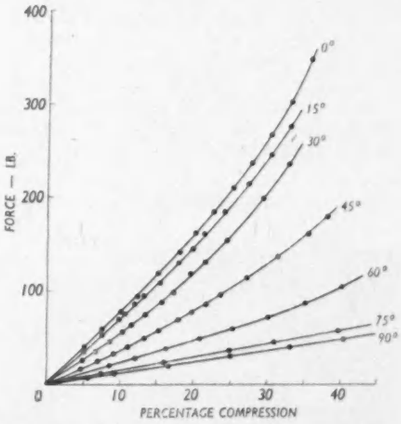


Fig. 23—Force versus displacement expressed as a percentage of cylinder height

The abscissa shown is percentage strain, or the ratio d/l expressed as percentage of the cylinder height. There is an approximately linear relationship between force and percentage deflection for $\alpha=75$ deg. and 90 deg., but not for less than 75 deg.

To simplify the comparison of the experimental results with the theoretical equations, the values of F_T both experimentally and theoretically are compared at compressions of 10, 20 and 30 per cent (Table IV) using a value of $G=75\cdot0$ lb per square inch obtained

TABLE IV

1 α	2 Shear component $2aG \times 0{\cdot}9d \sin^2 \alpha/l$ lb	3 Compression component $2aG(\lambda-\lambda^{-2}) \times 1{\cdot}413 \cos \alpha$ lb	4 F_T theoretical lb	5 F_T experimental lb	6 Theoretical / Experimental
		10 per cent compression, $d/l=0{\cdot}90$			
0 deg.	0	68·6	69	70	1·02
15 deg.	0·9	63·2	64	64	1·00
30 deg.	3·3	47·6	50	49	1·02
45 deg.	6·5	32·9	39	36	1·08
60 deg.	9·8	15·9	25	25	1·00
75 deg.	12·2	4·0	16	16	1·00
90 deg.	13·1	0·0	13	12	1·08
		20 per cent compression, $d/l=0{\cdot}80$			
0 deg.	0	156	156	160	0·98
15 deg.	1·7	143	145	148	0·98
30 deg.	6·5	112	119	122	0·98
45 deg.	13·1	74	87	81	1·08
60 deg.	19·6	34	54	49	1·10
75 deg.	24·4	10	34	32	1·06
90 deg.	26·1	0	26	25	1·04
		30 per cent compression, $d/l=0{\cdot}70$			
0 deg.	0	274	274	274	1·00
15 deg.	2·5	249	252	250	1·01
30 deg.	9·8	193	203	218	0·93
45 deg.	19·6	118	138	133	1·04
60 deg.	29·4	56	85	76	1·12
75 deg.	36·7	13	50	47	1·06
90 deg.	39·2	0	39	38	1·03

from a plot of F_T against $(\lambda-\lambda^{-2})$ and using equation (3).

The first column is the angle α at which the rubber is set. Column 2 is the theoretical shear component of F_T using the value for $2aG$ of 145 lb. Column 4 is the sum of columns 2 and 3 and is the theoretical F_T value ; these results agree well with the practical results in column 5, the ratio of theoretical to experimental values being given in column 6.

CONCLUSIONS

The theoretical force/deflection relationship derived above gives a fair description of the change in this relationship with change in α, as the ratios of the theoretical and the practical values of F_T in column 6 are close to unity. Even though mixing and vulcanisation conditions remained the same, it is expected that variations due to inhomogeneity of the material and the inevitable slight departure from geometrical form will account for a substantial part of the deviation from unity. Further slight deviations could probably be accounted for by the inevitable approximations necessary in deriving the equations, and the necessary empiricism of the compression shape function and in obtaining the constant $2aG$ used in the theory. Nevertheless for engineering design considerations, the theoretical relationship will give satisfactory practical values.

APPENDIX I

Composition of Rubber Compounds Used

Ingredients	Mix A	B	C	D	E	F	H
Smoked sheet	100	100	100	—	—	—	—
Neoprene GN	—	—	—	100	100	100	—
Polysar Krylene	—	—	—	—	—	—	100
Zinc oxide	3	3	3	1	1	1	3
Stearic acid	2	2	2	2	2	2	2
Light calcined magnesia	—	—	—	4	4	4	—
Pine tar	—	—	4·5	—	—	4·5	—
Dutrex R	—	—	—	—	—	—	5
Precipitated barium sulphate	—	200	—	—	200	—	—
HAF carbon black	—	—	50	—	—	50	50
MBT	0·5	0·8	0·5	—	—	—	—
Cyclohexylbenzthiazyl sulphenamide	—	—	—	—	—	—	0·9
Sulphur	2·5	2·5	2·5	—	—	—	1·75

All stocks were vulcanised at 141 deg. Cent. (40 lb steam pressure), except mix *H* which was vulcanised at 148 deg. Cent. (50 lb steam pressure) for a range of times. The particular specimens used for these tests were vulcanised at the "optimum cure time" as determined from test on the range of vulcanisates.

ACKNOWLEDGMENTS

Thanks are due to the Council of the Research Association of British Rubber Manufacturers for permission to publish this paper, which is based on the Research Association of British Rubber Manufacturers Research Memorandum R.404 and Research Reports 77 and 84.

REFERENCES

Ariano, R. (1928), *India Rubber World*, Vol. 76, page 207, "Resistance of Rubber to Compression."

Brown, R. W. (1940), *Society of Automotive Engineers Journal*, Vol. 47, page 28, "Properties of Rubber and Their Utilisation."

Cain, B. S. (1940), *Vibration of Rail and Road Vehicles*, New York, Pitman Publishing Corporation, page 264.

Davies, D. M. (1953), Ph.D., Thesis London University, "Effect of Frequency on Behaviour of Rubber Under Cyclical Deformation."

De Meij, S., and van Amerongen, G. J. (1954), paper read at the Deutsche Kautschuk-Gesellschaft, Munich, October 21 to 23, "Dynamic Mechanical Properties of Rubber Mixes."

Downie-Smith, J. F. (1938), *Journal of Applied Mechanics*, Vol. 5, No. 1, A–13, "Rubber Mountings."

Downie-Smith, J. F. (1941), *India Rubber World*, Vol 103, No. 4, page 39, "Rubber Springs Under Compression Loading."

Gent, A. N. (1957), *Rubber in Engineering Conference*, The National Rubber Development Board Publication, page 25, "Load-Deflection Relations and Surface Strain Distributions for Flat Rubber Pads."

Hattori and Takei, K. (1950), *Journal of the Society of the Rubber Industry*, Japan, Vol. 23, page 194, "The Stiffness of Compression Rubber Mountings."

Haushalter, F. L. (1938), *Society of Automotive Engineers Journal*, Vol. 42, No. 4, page 23, "Rubber as a Load Carrying Material."

Hirschfeld, C. F., and Piron, E. H. (1937), *Trans. of the American Society of Mechanical Engineers*, Vol. 59, page 471, "Rubber Cushioning Device."

Jenkins, H. F. L. (1948), *Trans. of the Institution of the Rubber Industry*, Vol. 23, page 231, "Rubber Anti-Vibration Devices."

Jenkins, H. F. L., and Cooper, D. H. D. (1948), *Proceedings o the Second Rubber Technology Conference*, London, page 214, "Load Deflection Factors in the Design of Rubber Suspension Units."

Kainradl, P. von, and Handler, F. (1956), paper read at the Deutsche Kautschuk - Gesellschaft, Traiskirchen, Austria, May 9, 1956, "Deformation Properties of Rubber Vulcanisates."

Keys, W. C. (1937), *Mechanical Engineering*, Vol. 59, page 345, quoted in *Rubber in Engineering*, 1945, page 236. The Services Rubber Investigations, H.M. Stationery Office.

Kimmich, E. G. (1940), *India Rubber World*, Vol. 103, page 45, "Rubber in Compression."

Kimmich, E. G. (1957), *Engineering Uses of Rubber*, edited by McPherson, A. J., and Klemin, A., Reinhold Publishing Corporation, New York, "General Engineering Properties of Rubber."

Kosten, C. W. (1940), Rubber Stitchting Communication No. 16, Amsterdam, "Rubber an Anti-Vibration Material."

Love, A. E. H. (1906), *The Mathematical Theory of Elasticity*, second edition, page 230, Cambridge University Press.

Mullins, L., and Tobin, N. R. (1954), *Proceedings of the Third Rubber Technology Conference*, London, page 397.

Parkinson, D., and Gough, V. E. (1941), *Trans. of the Institution of the Rubber Industry*, Vol. 17, page 168, "Dunlop Fatigue Test for Rubber Compounds."

Payne, A. R. (1956*a*), *Nature*, Vol. 177, page 1174, "Effect of Shape on the Static and Dynamic Stress Strain Relationship of Bonded Rubber in Compression."

Payne, A. R. (1956*b*), *Revue Generale du Caoutchouc*, Vol. 33, page 885, "A Non-Resonant Sinusoidal Strain Machine for Dynamic Testing of Polymers."

Payne, A. R., and Smith, J. F. (1956), *Journal of Scientific Instruments*, Vol. 33, page 432, "Dynamometer for the Tensile Testing of High Polymers."

Reising, E. F., and Gieck, J. E. (1957), *Engineering Uses of Rubber*, edited by McPherson, A. J., and Klemin, A., Reinhold Publishing Company, New York, "Rubber Products for New and Special Purposes."

Rocard, Y. (1937), *Journal de Physique et la Radium*, Vol. 8, page 197, "Note sur le Calcul des Propriétés Elastiques des Supports en Caoutchouc Adherent."

Rivlin, R. S., and Saunders, D. W. (1949), *Trans. of the Institution of the Rubber Industry*, Vol. 24, page 296, "Cylindrical Shear Mountings."

Rivlin, R. S. (1948), *Proceedings of the Second Rubber Technology Conference*, London, page 204, "Applications of Elasticity Theory to Rubber Engineering."

Saunders, D. W. (1948), *Proceedings of the Second Rubber Technology Conference*, London, page 213, discussions on "Applications of Elasticity Theory to Rubber Engineering."

Schay, G., and Ször, R. (1952), *Acta Chimica Hungarlena*, Vol. 2, No. 4, page 317, "Stress-Strain Relation of Rubber Blocks Under Compression."

Southwell, R. V. (1944), *Introduction to the Theory of Elasticity*, second edition, page 191, Oxford University Press.

Ore Carrier "Morar"

Scottish Ore Carriers, Ltd., took delivery of the T.V. "Morar," of 9250 tons deadweight, which was built by Lithgows, Ltd., and engined by Rankin and Blackmore, Ltd. The propulsion machinery is a free piston exhaust gas turbine installation consisting of three 1230 gas horsepower free piston gasifiers supplying a reversing gas turbine which develops 2500 s.h.p. and drives through double reduction gearing to give the ship a service speed of 11 knots.

RECENTLY the ore carrier "Morar" completed trials and made a series of runs on the Clyde to demonstrate, to owners, builders and others technically interested, the operation of the free-piston gasifiers and geared turbine machinery. The ship, which was built at the Kingston yard of Lithgows, Ltd., for Scottish Ore Carriers, Ltd., is the first British-built vessel to be equipped with this design of prime mover, and the following are the main particulars.

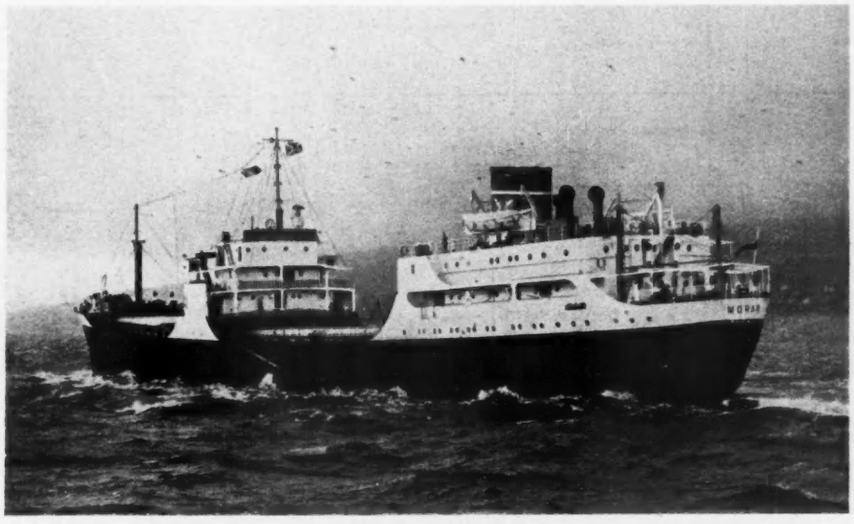
Length overall	427ft
Length between perpendiculars	407ft
Breadth moulded	57ft 3in
Depth moulded	32ft 3in
Draught	25ft 3½in
Block coefficient	0·77
Deadweight	9250 tons
Service speed	11 knots
Propelling machinery	2500 s.h.p.

The "Morar," shown on trials in our illustration, is the fourth ship to join the fleet, the others being the "Gleddoch," "Ormsary" and "Arisaig," and is mainly of riveted construction, with the machinery arranged aft.

An electric windlass and associated cable stoppers are mounted on the forecastle, as is also a warping capstan, with motor on the upper deck, placed just forward of the mast which carries a 5-ton derrick. The latter is stowed vertically and can be used as a foremast. Two 9½in by 10in capstans of 7 tons capacity are located on the poop deck aft, as are also two 1½-ton derricks. Two aluminium alloy accommodation ladders, made in two flights with a turntable top platform, are provided and four positions arranged, namely to port and starboard on the poop deck and on the upper deck between Nos. 3 and 4 hatches. Steering is effected by a streamline rudder operated by a Hastie electro-hydraulic steering gear, while on the navigating bridge are located a Decca navigator, Marconi radar, Sperry gyro compass and Pneumercator draught gauges. No deck machinery and cargo handling equipment is provided and the cargo is carried in four holds which are bounded by two fore and aft bulkheads sited at 17ft 6in to port and starboard from the centre line. The wing spaces outside these longitudinal bulkheads form water ballast tanks and below the ore holds is a 7ft high double bottom arranged for water ballast. Between Nos. 2 and No. 3 holds is an oil fuel bunker: a pipe passageway below the upper deck and within the starboard wing ballast tanks gives

fore and aft access to link poop, bridge and forecastle.

All four hatchways are fitted with "Ermans" hatch covers which are the first to be built in this country and were manufactured by R. Y. Pickering and Co., Ltd. These covers, illustrated herewith, consist of steel plate transverse panels folded to a deep trough shape and linked together. The articulated cover slides horizontally and rolls itself on to a long electrically rotated barrel, and watertightness is ensured by rubber conveyor belting having a double textile core. When the cover is in position the hold is free from rain and at sea a hoop iron secures the longitudinal joint in a manner similar to that used for securing tarpaulins. On the "Morar" the drive consisted of a 10 h.p. motor driving through a 700 to 1 reducing gear, limit switches and a mechanical deck stop. A hatch 30ft wide and about 50ft long was uncovered within two minutes.



Ore carrier "Morar" on trial on the Clyde

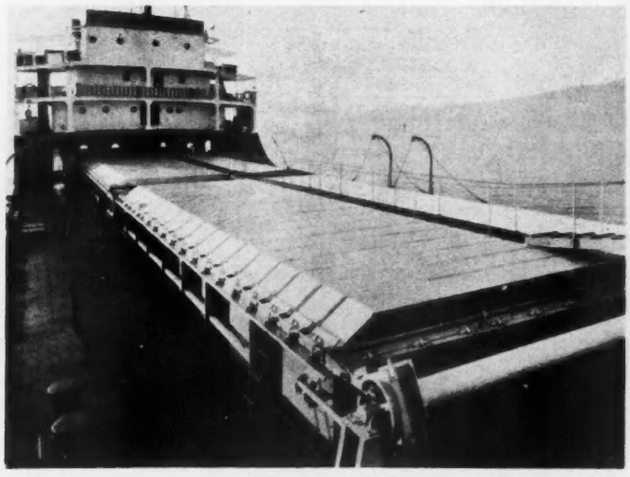
Machinery

The free piston exhaust gas turbine machinery fitted in "Morar" is the first such installation to be employed as the main propulsion unit in a British ship. Such machinery has been installed, however, in the two French coasters "Cantenac" and "Merignac," and a number of French minesweepers, the German trawler "Sagitta," and the Liberty Ship "William Patterson," which was converted to this form of propulsion for experimental purposes. The installation consists of three free piston gasifiers which supply the exhaust gas turbine driving the propeller through reduction gearing, the machinery developing 2500 service s.h.p.

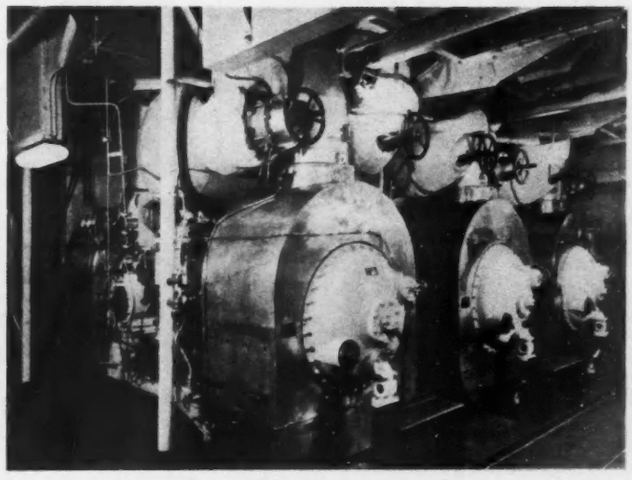
The gasifiers, seen in our illustration and supplied by the Free Piston Engine Company, Ltd., and manufactured under licence from Alan Muntz and Co., Ltd., have a bore of 13·4in by a full load stroke of 17·4in, and are each designed to provide 1230 gas horsepower, equivalent to about 1000 s.h.p., thus ensuring an adequate reserve of power. Gas pressure is 43 lb per square inch gauge and the temperature about 825 deg. Fah., and each unit weighs 8 tons and measures approximately 14ft overall.

Rankin and Blackmore, Ltd., has built the turbine to the designs of Power Jets (Research and Development), Ltd., and it is a prototype unit intended to prove mechanical reliability; we include a view of the turbine looking at the forward end. There are six ahead and two astern stages, the latter being incorporated in the main casing, and a blading efficiency of 86 per cent has been attained on test by the ahead stages but, since this is a reversing turbine, the overall efficiency is less by the amount of power absorbed by windage of the astern blades. Test bed trials revealed that other losses in efficiency resulted from excessive swallowing capacity and the restriction of the outlet volume which gave rise to parasitic gas flow. The latter has been overcome to a great extent by the fitting of a movable mask. As a result of these faults and the consequent reduction in efficiency of the turbine, the fuel consumption is higher than expected at 0·49 lb per shaft horsepower per hour on a gasifier consumption of 0·335 lb per gas horsepower per hour. These teething troubles are fully understood: a new turbine is under construction which embodies the lessons learned from the prototype and it is expected to attain a fuel consumption of 0·42 lb per shaft horsepower per hour. It will replace the turbine presently in service, which will be used for research purposes by the Lithgow Power Development Company, Ltd., a company formed to co-ordinate the resources of Lithgows, Ltd., in the research, development and advancement of marine propulsion, not excluding nuclear energy. It is thought that the consumption quoted can be improved by further refinements in the design of the direct reversing turbine, which is simple and highly manœuvrable, while a non-reversing turbine with separate astern wheel will give even better figures.

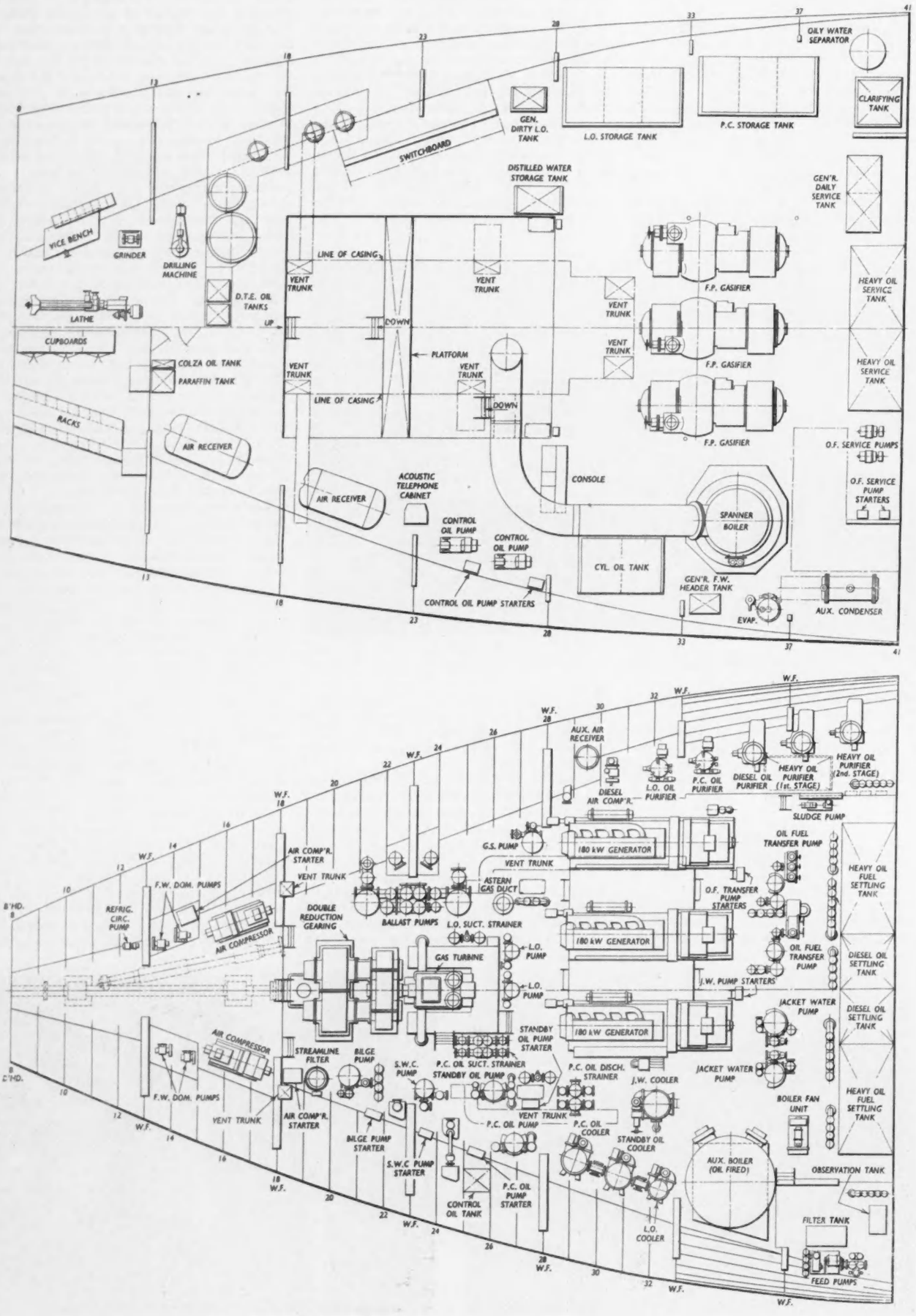
The turbine installed is of double casing design with the inner shell carrying the fixed blades, while the fabricated outer casing carries external attachments and is subjected only to exhaust pressure and temperature. Built-up drum construction was adopted for the rotor and the design provides for thermal stresses, arising from uneven heating when starting and manœuvring, being kept to a minimum. There are two gas inlets to both ahead and astern sections of the turbine. Control of the machinery is from a console, located to starboard on the gasifier flat, and illustrated herewith, by hydraulic means, a pair of Drysdale motor-driven pumps supplying the fluid at the required pressure. A single handwheel regulates the load on the gasifiers and also the proportioning valve which directs the exhaust gas to the ahead or astern turbines as required, or in varying proportions to both turbines to provide fine adjustment when manœuvring, modulated pressure to the proportioning valve bellows determining the position of the valve. The turbine governor operates in two stages; at moderate overspeed the position of the proportioning valve is altered to reduce the gas to the ahead turbine and direct the surplus



"Ermans" hatch covers shown with opening and closing mechanism in foreground



Three "GS-34" free piston gasifiers



General arrangement of main and auxiliary machinery

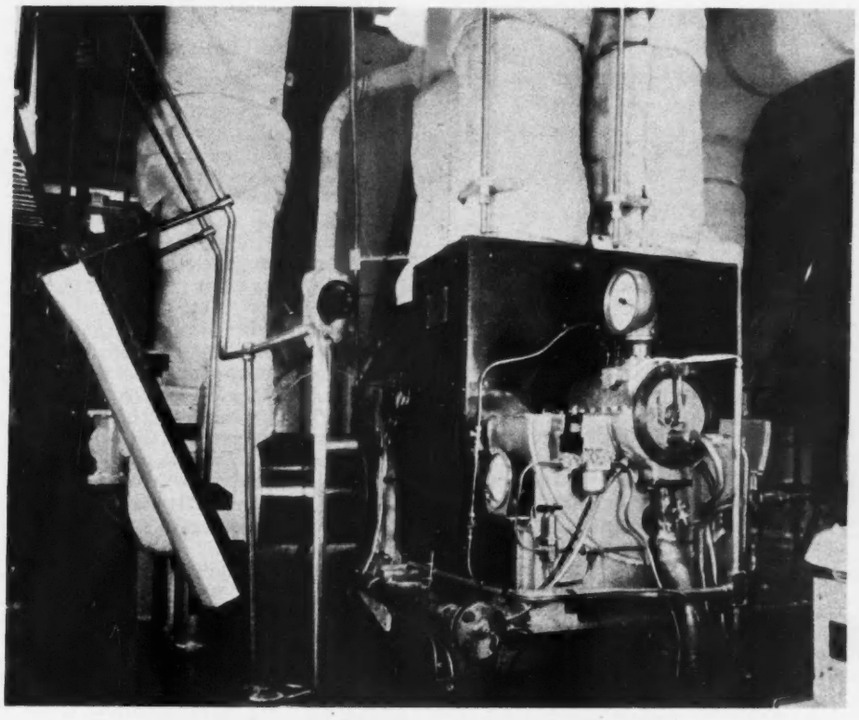
gas to the astern section. There is also an overspeed trip on the turbine together with a device which, in the event of a failure in the supply of lubricating oil, cuts off the gasifier fuel and returns the proportioning valve to the neutral position.

At present the gasifiers are burning 900 seconds fuel but it is possible to use fuel up to 1500 seconds viscosity. Another company of the Lithgow group, the Fairfield Shipbuilding and Engineering Company, Ltd., was responsible for the dual tandem double helical reduction gearing which reduces an input shaft speed of 5250 r.p.m. to 115 r.p.m. at the propeller shaft, and can be seen in our illustration. The pinions are of 40–45 tons per square inch 3 per cent nickel forged steel and the main wheel has a cast iron centre keyed to a forged steel spindle and has a shrunk-on forged steel rim, the primary wheels being of similar construction. The primary pinions have a pitch of 4/10in, a 16 deg. flank angle and a 30 deg. helical angle and a p.c.d. of 6·2in, while the primary wheels have a p.c.d. of 38·4in, a width of 14½in and a gap of 2¾in. The secondary pinions have a p.c.d. of 12·1in, a width of 24in and a 3in gap, and the main wheel has a p.c.d. of 89in. There is a primary flexible coupling, consisting of two claw members with external teeth bolted to the primary pinion and turbine flanges and a quill shaft flexible coupling at the aft end of each secondary pinion. Electrical turning gear is installed.

Rankin and Blackmore, Ltd., was responsible for the arrangement and installation of the machinery, and it is of interest to note that, compared with a sister ship, the length of the engine-room could have been reduced by as much as ten frame spaces. However, only five frame spaces were used and the poop reduced by this amount without sacrifice of accommodation area since the engine casing is nine frame spaces shorter and 6ft less in width. The general arrangement of main and auxiliary machinery is shown in our line drawing. The reduction in length of the engine-room has increased the bale capacity by 12,411 cubic feet and provided for an increase of 309 tons in water ballast capacity. Another point is that the estimated weight of machinery is 410 tons compared with 630 tons for a sister ship, thus adding about 200 tons to the deadweight. The auxiliary machinery supplied is similar to that installed for diesel main propulsion, and most of the pumps are of Drysdale's manufacture including two 350 tons per hour ballast pumps. "Titan" purifiers handle the heavy oil, diesel oil and lubricating oil, while Serck coolers deal with fresh water, lubricating oil and piston cooling oil. There are Auto-Klean strainers and the ship services are supplied by a Spanner vertical oil-fired boiler, while electrical requirements are met by three 180kW Campbell and Isherwood generators, each driven by a Ruston and Hornsby diesel engine.

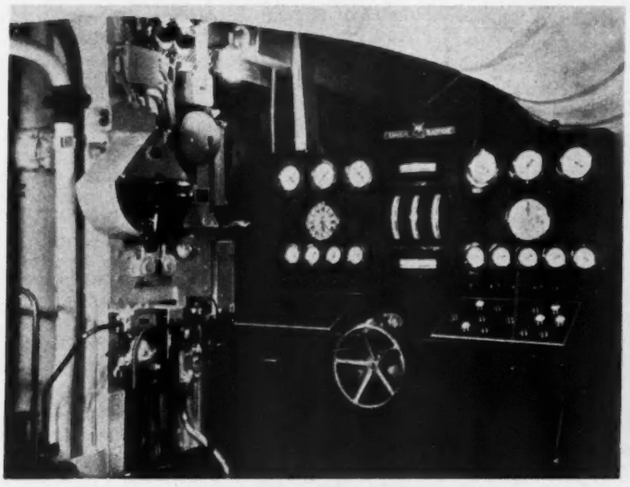
With the gasifiers drawing air through an intake in the funnel rather than direct from the engine-room, the objectionable air pulsations have been eliminated, and during trial runs it was noteworthy that noise usually associated with free piston gasifiers had been reduced to a reasonable level. This effect has been achieved fairly simply by the fitting, in addition to other measures, of panels suspended from the deck over to form sound absorbing screens, about 3ft deep, extending over a considerable length of the engine-room.

On trials the ship attained a speed of 12 knots with three gasifiers in operation, and with one gasifier shut down a speed of 5 knots was reached in four minutes from dead stop and 9 knots at the end of eight minutes. The trials also demonstrated the value of a multiple unit power installation since the ship was able to maintain adequate speed with one gasifier out of action.

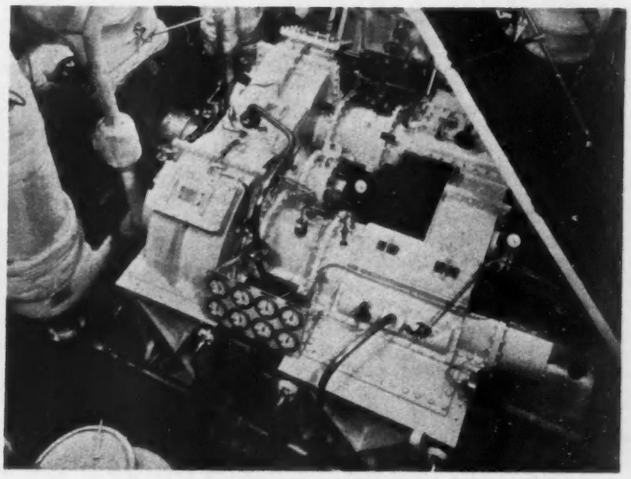


Gas turbine, viewed from forward and showing gas intakes

CO_2 "BARE WIRE" WELDING.—Equipment for the CO_2 "bare wire" welding process has been introduced by Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. Basically, the machine consists of a welding head which carries the wire at the appropriate feed rate and surrounds the arc with an atmosphere of CO_2. A single control lever engages the wire feed and switches on the carriage motor and arc. Water cooling is independent of mains supplies. It is stated that the process can be used for welding a wide range of steel grades, and the welds are homogeneous and of deep and even penetration.



Machinery control console



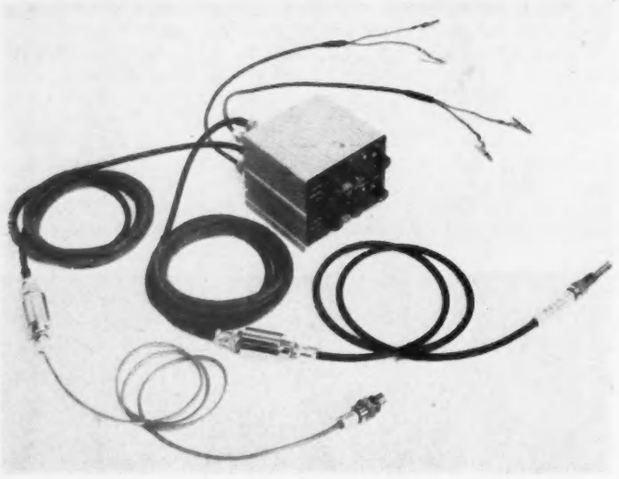
Double helical reduction gearing

Fully Transistorised Frequency Modulated Indicator for Field Tests

By R. C. ROBSON, B.Sc. (Hons.),* A. GOODIER,* AND R. G. PENN†

No. I

An electronic indicator for translating mechanical parameters into electrical ones has been developed for field use by the Thornton Research Centre, Chester, and is described here. In it thermionic valves have been replaced by transistors and crystal diodes. It has proved to be so reliable in service that it is expected to make obsolete most of the indicators at present used by Shell Research, Ltd.



THE oil industry is typical of many other industries in that each of its major operations, namely, exploration and production, manufacture, transport and storage, and marketing, is supported by research. The sort of research which supports marketing is known as applicational research. Thornton Research Centre, near Chester, carries out this work for the non-dollar marketing areas of the "Shell" group. It concerns the performance of petroleum products. Its purpose is the development of oil products suitable for given applications. For example, the advent of the aircraft gas turbine engine has called for the provision of a new range of fuels and lubricants.

Applicational research begins and ends in the field. It begins in the field because it is there that the need for a new product arises. It ends there because the results of successful research are used in the field. An essential part of applicational research is thus the investigation of product performance under realistic conditions. Wherever possible oil products should be tested by being used exactly as the customer uses them.

Because the oil industry sells energy, a very important part of Thornton's work is to know how petroleum products perform in engines and to understand why they behave as they do. It is essential that the tests which provide the information about the performance of fuels and lubricants are carried out with the mechanical equipment operating as its designer intended. For example, when measuring the fuel consumption obtained with a number of different types of diesel fuel in a given engine, the injection timing must be checked while the engine is running on each fuel. Otherwise the results of the tests are worthless. This need to find out what is happening in machinery while it is running at normal speed and load can only be met by the use of electronic techniques. The accelerations of the moving parts (e.g. fuel injector needle) are generally so high that mechanical methods of observing their movement cannot be used. The Centre thus has a continuing need for electronic indicators, i.e. electronic systems which are capable of translating mechanical parameters into corresponding electrical ones (e.g. needle lift into voltage) and presenting the information in a suitable way—usually as a diagram on the face of a cathode-ray tube.

So long as electronic indicators are confined to the laboratory they work reasonably well. However, they are not suited to the arduous conditions met in tests in the field, mainly because thermionic valves are fragile and work at high voltages. We have therefore designed an electronic indicator from which all thermionic devices have been eliminated. This has been possible because transistors and crystal diodes have recently become commercially available. These new components perform many of the functions of valves, but they are very robust and will work at low voltages. We have tried to make the new indicator specially suitable for field use, as this is the application where conventional apparatus serves us worst. However, we have found that electronic equipment from which thermionic valves have been eliminated is so reliable that we expect the new indicator will ultimately make most of our existing indicators obsolete. The purpose of this article is to describe the new indicator and to give details of its performance.

* "Shell" Research, Ltd., Thornton Research Centre, P.O. Box 1, Chester.
† Now with Shell-Mex and B.P., Ltd.

Conventional Electronic Apparatus is Difficult to Use Outside the Laboratory

From time to time it has been necessary to obtain field data concerning rapidly varying mechanical quantities (explosion pressures, for example) which can only be measured by the use of electronic equipment. Laboratory apparatus has perforce been used on these occasions. This experience has shown it to be unsuitable for field use because :

(i) It is difficult to provide the necessary supply of power at mains voltage and frequency, especially in a mobile installation.

(ii) The apparatus is easily put out of action by the condensation of moisture upon it.

(iii) It is unsafe to use in the presence of inflammable vapours.

(iv) It is fragile.

(v) It is microphonic, i.e. vibration shakes the electrode structures within the valves and causes them to generate false signals.

(vi) It is heavy and bulky.

New Possibilities for the Design of Electronic Indicators

As long as electronics was thought of solely in terms of thermionic devices, there was little chance of eradicating the above deficiencies of electrical indicating systems. However, this situation has recently been completely transformed. Transistors and crystal diodes have the following advantages over thermionic valves for the design of field test equipment :

(i) They require no filament power supplies. They operate entirely on low voltage circuits running at very low power levels in the milliwatt range.

(ii) They are very small and light.

(iii) They are completely unaffected by vibration.

(iv) Their life is extremely long. Because of the low power level at which transistor circuits may be operated, the components used with them never become over-heated and their lives, too, are correspondingly prolonged.

(v) They have no warm-up time. Circuits function immediately they are switched on.

On the other hand, the use of transistors at the present time has the following disadvantages :

(i) It is necessary to learn new circuit techniques.

(ii) Transistors are very difficult to make in quantity. The characteristics of nominally identical transistors differ even more than those of a batch of valves.

(iii) All the transistors currently available are very temperature sensitive.

(iv) Transistors are seriously limited in the frequency range of the signals they can handle.

On balance these considerations indicated that a useful indicator might be made even with the components at present available. The design problem was to employ the new circuit elements in such a way that their acknowledged deficiencies did not impair the performance of the indicating system too much.

The Requirements for a Field Test Indicator

The function of an electronic indicator is to convert a mechanical parameter (pressure, linear or angular displacement, acceleration, &c.) into a proportional electrical one and present it suitably. A single indicating channel therefore comprises three parts, thus :

(i) A "pick-up" or transducer. This part of the system converts the mechanical quantity under investigation into a corresponding electrical one.

(ii) A "black box," the indicator proper. This part converts the information supplied by the transducer into an output voltage suitable for driving

(iii) a display unit. This part presents the information from the indicator in a form in which it can be read off or recorded.

A satisfactory indicator must be versatile in the sense that it must accept information from a wide variety of "pick-ups." These differ greatly in mechanical design according to their purpose. None the less, all those used with a given indicator must have certain electrical parameters in common. A versatile indicator is one which places few restrictions

on the mechanical design of its transducers.

A satisfactory indicator must also be versatile in the sense of being capable of driving display units requiring different electrical inputs. The method of presenting the information provided by the indicator depends primarily on the speed of the phenomenon under investigation. In order to delineate a varying parameter faithfully, the display unit must be able to follow the highest frequencies present in the signal applied to it. The usual display units are :

(i) Moving coil micro-ammeter. This is suitable for static and slowly varying parameters. If it is desired to record the data, a self-balancing potentiometric recorder may be used.

(ii) High-speed pen recorder. This is suitable for signals containing frequencies up to about 100 c/s. Several watts of driving power are needed in order to overcome the inertia of the pen. Thus it is necessary to interpose a power amplifier between the indicator and the recorder. This facility is provided as an accessory to commercial recorders.

(iii) Cathode-ray oscilloscope. This will deal with frequencies far in excess of those associated with mechanical parameters, so that the fidelity of the complete indicator will usually be limited by the transducer. Several hundred volts (although at a very low power level) are needed to swing the beam of a C.R.O. Thus a voltage amplifier is required between the indicator proper and the cathode-ray tube. This facility is built into most commercial oscilloscopes. If it is desired to record the data this may be done photographically.

It will be observed that the indicator must work into an impedance of a few hundred ohms when used with a micro-ammeter, and into a high impedance (usually about 1 megohm) when it is used to drive an amplifier. In order to transfer its power efficiently to the various alternative display units it therefore requires two outputs, one at low and one at high impedance.

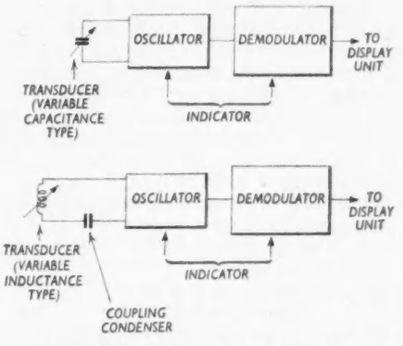
A satisfactory indicator must reproduce the information provided by its transducer with a high degree of fidelity. It must therefore be a strictly linear device capable of handling signals spanning a wide frequency band. Its fidelity must depend as far as possible only on the characteristics of stable circuit elements. On no account must it depend directly on valve or transistor characteristics because the former drift with time, and those of the latter vary greatly between individuals. The transfer characteristics (increment of mechanical parameter per volt output) of the indicator must be stable over periods very long in comparison with the time taken to make a set of measurements. It must be immune, as far as possible, to electrical, magnetic and mechanical (vibration) sources of interference.

A satisfactory indicator must be easy to set up and calibrate. In practice this means it must be susceptible to static calibration. It must also be small, light and self-contained as regards its power supplies. It will be observed that none of the above requirements conflicts in any way with what is needed for a laboratory indicator.

How the New Indicator Works

The frequency ($f=\omega/2\pi$) generated by an electronic oscillator is determined by the inductance L and capacitance C of its tuned circuit according to the expression $\omega^2LC=1$. This frequency is independent, to a high degree of approximation, of the characteristics of the active circuit element (valve or transistor) used to sustain the oscillations. An oscillator whose resonant circuit comprises a stable inductance and a stable capacitance will therefore generate a frequency which remains constant over long periods.

Consider a radio-frequency oscillator, as shown in the upper part of Fig. 1, which has an external variable capacitor connected in parallel with that in its resonant circuit. It will generate a frequency determined by the total capacitance, internal and external alike. Thus each setting of the external capacitor will correspond to a certain frequency of oscillation. Hence, by measuring this frequency, we may deduce the value of the external capacitor.



Above : With variable capacitance " pick-up."
Below : With variable inductance " pick-up."

Fig. 1—The essentials of a frequency modulated indicating system

If the external capacitor is such that its capacitance is a unique function of some mechanical quantity (i.e. a variable capacitance transducer), a measurement of the oscillator's frequency will define this quantity. The combination of transducer and oscillator thus forms an electronic indicator.

However, an electrical output in the form of a varying or modulated frequency is not convenient for a field test indicator. It is therefore necessary to introduce an auxiliary " black box " which converts the information contained in the oscillator's output into a form that conventional display units can accept. This box is known as a demodulator. Its output is a direct voltage strictly proportional to the difference between the frequency of the oscillator at any instant and some arbitrary fixed frequency. The complete frequency modulation (F.M.) indicator, comprising transducer, oscillator and demodulator, thus converts a mechanical parameter (measured from some arbitrary initial state) into a proportional d.c. voltage.[1]

It is evident from the symmetry of the expression for the oscillator's frequency that it may be modulated by inductance increments in just the same way as by increments of capacity.[2] However, it is not very practical to open the oscillator's resonant circuit and insert a transducer in the form of a series inductance. A transducer used in this position, moreover, would need to have very low electrical losses and this requirement would unduly restrict its mechanical design. These difficulties may be circumvented by the arrangement shown in the lower half of Fig. 1 in which the variable inductance transducer is connected to the oscillator via a series coupling condenser.

From the above general description it will already be observed that the F.M. system meets a number of the requirements for a satisfactory indicator :

(i) It is unusually versatile because it will accept information from two distinct families of transducers—those which convert mechanical changes to capacity changes and those which convert them to increments of inductance.

(ii) The stability of the transfer characteristics of the oscillator is determined only by the stability of fixed capacitances and inductances, which is very high.

(iii) The system is easy to calibrate statically, by adjusting the mechanical parameter incrementally and observing the corresponding indications of the display unit.[3]

We are now in a position to consider each element of the indicator in more detail.

Transducers

As mentioned above, two families of transducers may be used with the indicator, depending upon whether the mechanical quantity to be measured may be more readily converted to a variable capacitance or to a variable inductance.

(I) Variable Capacitance Transducers

Variable capacitance transducers have been made in the following forms :

(*a*) *Linear Displacement Transducer.*—This transducer was designed to permit the display, on a high-speed pen recorder, of the closing characteristics of the hydraulically damped valve installed in a particular type of aircraft fuel dispenser. The information was needed in connection with the study of pressure surges in hydrant fuelling systems.

The spring-loaded valve of the dispenser, when suddenly released from the fully open position, slowly moves a distance of 0·465in when shutting itself. The transducer is mounted on a bracket attached to the top cap of the refuelling nozzle, with the end of its spindle G (see Fig. 2) pressed against an extension of the valve spindle by spring R. The capacitance of the transducer is mainly determined by the narrow annular gap (approximately 0·020in) between the spindle and insulated electrode H, and the extent to

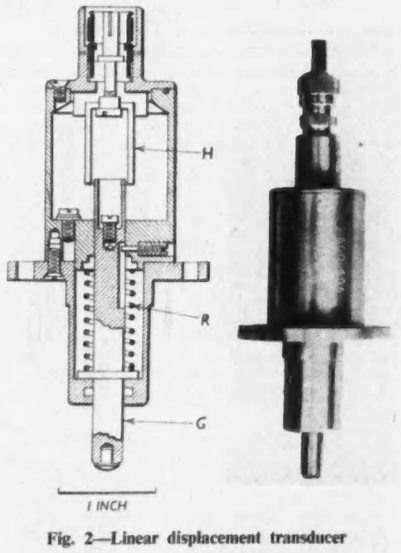


Fig. 2—Linear displacement transducer

[1] Frequency modulation is widely used in telemetry, because information in the form of frequency changes may be transmitted over a radio link without distortion. It also forms the basis of a versatile high fidelity laboratory indicating system. Despite its technical merits, however, this indicator in its conventional and commercially available form is so complex and bulky that the practice at Thornton is to use it only where nothing else can be pressed into service.

[2] For a small change of capacity (dC) the corresponding frequency differential (df) is given by :

$$\frac{df}{f}=\frac{-1}{2}\frac{dC}{C}$$

Similarly, for a small change in inductance (dL) :—

$$\frac{df}{f}=\frac{-1}{2}\frac{dL}{L}$$

[3] This is not the case for systems which use voltage generating transducers (e.g. electromagnetic, piezo-electric, and magnetostriction types). These can only be calibrated dynamically.

Fig. 3—Angular displacement transducer

which they overlap. When fuel is being delivered at the maximum flow rate the spindle enters the electrode nearly as far as it will go and the transducer presents its maximum capacitance to the oscillator. When the fuel flow is cut off the spindle takes up approximately the position shown in the cross-sectional drawing of the transducer, which then has its minimum capacitance. The capacitance/displacement relation of the transducer is linear.

(*b*) *Angular Displacement Transducer.*—The transducer shown in Fig. 3 was designed to convert the angular rotation of the crankshaft of a two-stroke engine into synchronous capacitance changes having a saw-tooth waveform. Its purpose was to generate the time-base voltage required for displaying fuel injection characteristics of diesel engines.

A central shaft carries a set of shaped blades. These rotate between two diametrally disposed sets of narrow radial blades which are insulated. The rotating blades each have two lobes. They are of such a shape that the capacitance between the two blade sets increases linearly for the greater part of each 180 deg. of crank angle, and then decreases sharply (so as to produce a linear time base and a rapid fly-back).

As a matter of convenience an oscillator is built into this transducer, thus making it a self-contained time base generator. A similar transducer having single-lobed cams has been built for use with four-stroke engines.[4]

(*c*) *Cylinder Pressure Transducer.*—In order to measure faithfully the fluctuating pressure within the cylinder of an i.c. engine a transducer requires an excellent frequency response. It must also be extremely robust and immune to heat. Hard experience has taught us that no commercially available pressure transducer will meet these requirements satisfactorily. We have therefore made our own to the design shown in Fig. 4.

The effect of pressure on this transducer is to cause the flat end face of its body, *A*, to bow slightly (with a maximum deflection of about 0·0002 in) and approach insulated electrode *C*. The capacitance of the transducer is mainly that defined by the area of this electrode and the narrow gap (approximately 0·001in) between it and the end of the body.[5] When the effective gap is reduced by external pressure, the capacitance presented to the oscillator increases.

The internal diameter of the recess at the end of body *A* is 0·342in/0·343in and the diaphragm part is 0·047in/0·049in thick, (for a 1500 lb per square inch transducer). The natural frequency of the only moving part of the transducer (its steel diaphragm element) is thus extremely high. The transducer will therefore faithfully convert even high-frequency pressure fluctuations to corresponding capacitance changes. The electrode *C* is insulated by mica washers *D* at the hot end of the transducer, and by the polytetrafluoroethylene bush *L* at the (relatively) cool end. It will therefore withstand quite high temperatures.

Transducers for pressure ranges between 125 lb per square inch (0·015in/0·016in thick diaphragm) and 2500 lb per square inch (0·063in/0·065in thick diaphragm) have been made to the above design.[6]

(*d*) *Fuel Line Pressure Transducer.*—In order to measure the pressure pulses developed in the fuel injection system of a diesel engine a robust transducer is required capable of measuring pressures in excess of 10,000 lb per square inch.

A number of cylinder pressure transducers, as described above, were made having different thicknesses of diaphragm end. Their sensitivities (capacitance change per unit increment of pressure) were plotted against diaphragm thickness. It was seen that, once the diaphragm's thickness reached about 0·090in, any further increase made very little difference to the sensitivity. Clearly, some other part of the transducer started to distort appreciably at very high pressures. It was therefore necessary to design a new transducer having a much more rigidly encastred diaphragm.

Fig. 5 shows how this has been done. The diaphragm takes the form of a web made by machining body *A* from solid. When pressure is applied this web bows towards electrode *G* and increases the capacitance of the transducer.

Two other features of this design should be noted. The transducer adds negligible extra volume to the fuel injection system in which it is inserted. It has been made waterproof by potting its terminal assembly in " Epikote " resin.

(*e*) *Force Transducer.*—When it is required to measure impulsive forces a transducer very similar in design to that for cylinder pressure may be used, as shown in Fig. 6. The force in this particular case is the transient tension developed during the sudden breaking of a

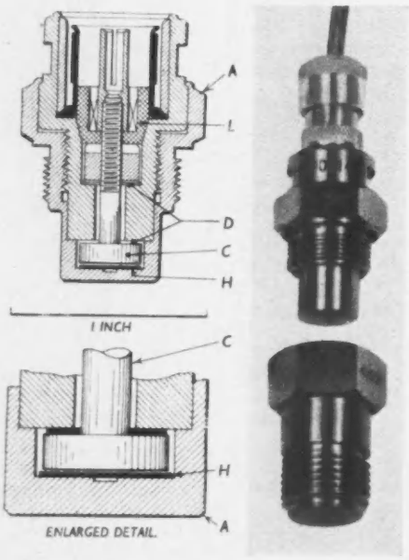


Fig. 4—Cylinder pressure transducer, with adaptor and high temperature cable used to connect it to its oscillator

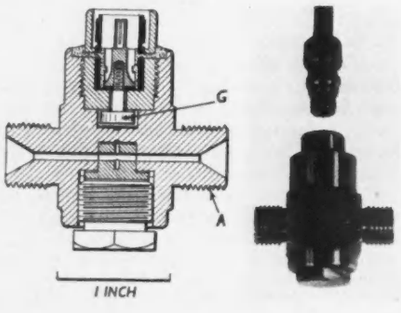


Fig. 5—Fuel line pressure transducer

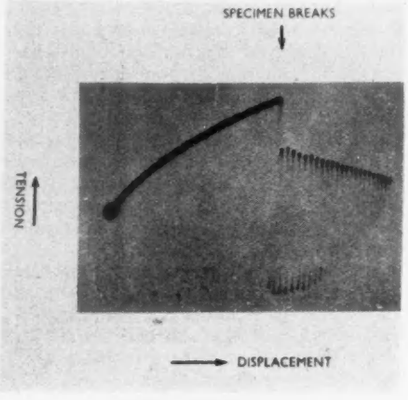


Fig. 6—Force transducer and oscilloscope record produced with its aid

[4] An important design feature is that the voltage from the oscillator is fed to the rotating plates via a series capacitance (large compared with the transducer proper) formed by two circular plates rotating in the gaps between three fixed ones. In this way the electrical noise which was invariably found to develop from sliding contacts has been eliminated.

The transducer in the form illustrated is obsolete. It was found to be microphonic. Severe vibration was capable of making the blade system vibrate, and caused corresponding electrical noise to appear on the time base. In future designs the narrow blades (increased in stiffness) will rotate between fixed circular plates having cam-shaped holes. An angular displacement transducer built in this way and attached to the fan belt pulley of a road test car (where vibration is extremely severe) has proved free from microphony.

[5] Of this 0·001in gap, only 0·0002in is air. The rest is taken up by a 0·0008in thick mica washer *H*, the main effect of which is to increase several-fold the sensitivity of the transducer.

[6] This pressure transducer differs from others we know in that its diaphragm element is integral with its body. The manufacture and assembly of the transducer has required the development of a special technique in which the clearance between the diaphragm body (*A*) and electrode (*C*) is measured electronically at several stages during the finishing operations. Past experience with commercially available variable capacitance pressure transducers has convinced us that designs in which the diaphragm is a separate element are most unsatisfactory. They are practically impossible to use for measuring pressures in liquids, because the liquid invariably creeps between the diaphragm and its seating. Once it gets into the critical gap where the capacitance of the transducer is concentrated, it causes gross errors. Similar errors arise when attempting engine cylinder pressure measurements, the liquid in this case being water which condenses on the transducer when the engine cools down.

3mm diameter by 1cm long bitumen test piece. The bitumen specimen is prepared hot and flowed into a tit which forms part of the diaphragm element of the transducer. Tensile stress in the bitumen increases the narrow gap between the diaphragm and the insulated electrode of the transducer, thus decreasing the capacitance presented to the oscillator.

The information produced by impulsively straining the bitumen is presented on a cathode-ray oscilloscope and recorded in the form shown in Fig. 6.[7] The *X* deflection of the C.R.O. is proportional to the extension of the struck end of the bitumen and the *Y* deflection is proportional to the tensile force

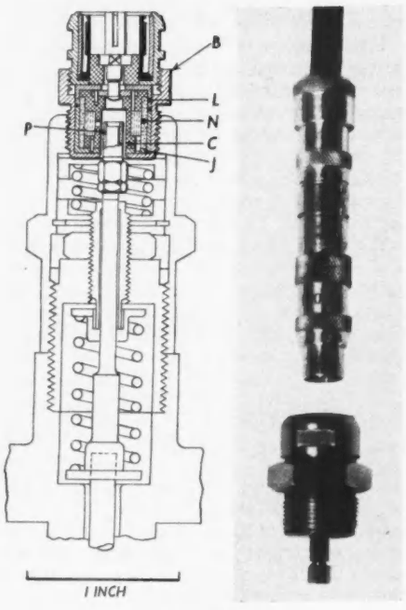


Fig. 7—Needle lift transducer (left) assembled on a diesel fuel injector, (right) complete with coupling condenser and cable which joins it to its oscillator

developed in it. A time scale is provided by low amplitude 10 kc/s modulation of the *Y* plates of the oscilloscope. It is apparent that despite loading by the tit and by the adhering portion of the broken test specimen, the diaphragm of the force transducer vibrates freely at about 20 kc/s. It will therefore measure faithfully even the rapidly varying forces developed in the bitumen during the 1 millisecond or so it takes to break. The transducer measures forces up to 4 kg weight and its diaphragm is 0·500in diameter by 0·040in thick.

(II) Variable Inductance Transducers

Variable inductance transducers are extremely useful where high sensitivity is required over a limited part of the range of the mechanical parameter. They also make useful displacement transducers for movements of the order of 1mm.[8]

(*a*) *Needle Lift Transducer.*—Needle lift diagrams are useful in the study of the performance of fuel injection systems. The movement of the needle is limited by stops at both ends of its travel and the most important point to be determined is whether single or multiple injections occur. Consequently, a transducer having strictly linear characteristics is not necessary.

The design shown in Fig. 7 is very satisfactory. It comprises an inductor whose inductance may be modulated by changes in the configuration of its magnetic circuit. The inductance coil is wound on a p.t.f.e. former *C* within a ferrite[9] sleeve *N* and screened by a copper can made up of parts *J* and *L*. The coil is made robust by encapsuling it in "Epikote" resin and mounting it in a threaded body *B*. An extension to the needle of the fuel injector carries a small ferrite tube *P* which enters the coil and is linked with its magnetic flux. The inductance presented to the oscillator increases as tube *P* enters further into the coil. With the best adjustment of *B* relative to *P* the transducer is linear within about 1 per cent over a distance of 0·030in.

(*b*) *Proximity Transducer.*—In the case of the variable inductance transducer shown in Fig. 8 the moving element of the magnetic circuit is part of the machinery whose motion is under observation. The transducer is an inductor whose coil is mounted between two ferrite sleeves and potted in "Epikote" resin. When a ferromagnetic body approaches the coil end of the transducer its inductance increases.[10]

The transducer was designed to investigate the closing characteristics of the exhaust valves of automotive engines. It is mounted with its axis parallel to that of the valve and with its sensitive end 0·020in away from the valve spring collet when the valve is in its closed position. The inductance/displacement

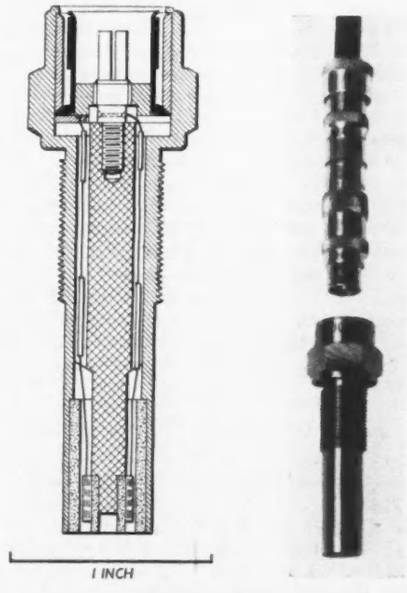


Fig. 8—Proximity transducer complete with coupling condenser and cable that connects it to its oscillator

characteristic is non-linear, the sensitivity increasing rapidly as the collet approaches the end of the transducer. This is exactly what is required for investigation of the mechanism of exhaust valve failure, in which the last stages of the valve closing characteristic are of particular interest.

It is proposed to use an array of six of these transducers to measure shaft eccentricity in a journal bearing rig now under construction. Three transducers, normal to the shaft and at 120 deg. to each other, will be used in each of two planes, one on each side of the bearing. A moving coil meter will display in turn the distance of each transducer from the rotating shaft, thus enabling its eccentricity within the bearing to be deduced.

(III) General

Each of the above groups of transducers have certain electrical characteristics in common. The variable capacitance types are designed to have an incremental capacitance of 5 micro-microfarads (pF). Their standing capacitance is not critical and values up to a few hundred pF can be tolerated. The design of the variable inductance transducers is rather empirical. It is, of course, essential that their electrical losses and degree of coupling to the oscillator should not be too great, or the latter will fail to work.

The above examples indicate the wide range of mechanical quantities for which transducers can be made. In general the conditions in which the transducer operates determine its mechanical design no less than the above electrical requirements. Its construction must permit it to operate satisfactorily under adverse conditions in which heat, water, oil, dirt and vibration may be present. The method of mounting transducers has to be worked out individually for most applications. However, in the case of cylinder pressure transducers, sufficient standardisation of indicator ports and sparking plug holes exists to warrant the provision of adaptors such as is seen in Fig. 4. There is also a limited degree of standardisation of fuel injectors, making it worth while to design the adaptors seen in Fig. 7.

(*To be continued*)

[7] In view of the sharp transients to be measured, the previously mentioned commercially available F.M. indicating system was used on this occasion because of its excellent frequency response.

[8] The linear displacement transducer described above becomes difficult to make for displacements less than about 0·250in because in order to maintain its incremental capacitance it is necessary to narrow the annular gap surrounding its moving element. A parallel plate type of variable capacitance transducer is not practicable for displacements greater than about 0·001in because the plate area has to be made very large in order to maintain the incremental capacitance.

[9] Ferrites combine high permeability with high resistivity and permit the construction of compact inductors having low R.F. losses.

[10] When a non-magnetic metal approaches the coil its inductance decreases because of the eddy currents generated in the metal by the coil's R.F. magnetic field.

Technical Reports

Low-Speed Wind-Tunnel Tests of the Effects of Various Leading-Edge Modifications on the Sectional Characteristics of a Thin Wing. By S. F. J. Butler, M.Sc. A.R.C. Current Paper No. 410. H.M. Stationery Office. Price 7s. 6d.—The effects of various leading-edge modifications on the low-speed characteristics of a 6 per cent thick R.A.E. 101 aerofoil are discussed, with particular attention to the effects on the upper surface flow separations. In addition to the tests on the basic round-nosed section, the effects of attaching an isolated strake and a row of strakes to the leading edge were investigated. Tests were also made on a sharp-nosed version, both with and without deflected nose flap.

The results show that all the leading-edge modifications had profound effects on the upper surface flow separations. At the test Reynolds number (2×10^6), the upper surface of the basic round-nosed section exhibited a "short bubble" flow up to 5 deg. incidence, above which incidence a "long bubble" developed, which spread to the wing trailing edge by 10 deg. Addition of a row of strakes inhibited the bubble growth and allowed a certain degree of peak negative pressure to occur near the leading edge, but the particular configuration tested did not increase $C_{L_{max}}$ or reduce the overall drag coefficient at a given lift coefficient. Addition of a sharp leading-edge extension caused the "long bubble" flow to develop from immediately above zero incidence. Deflection of the sharp leading edge caused the upper surface flow to remain attached, except for a localised region on the deflected nose, right up to the stall.

As a result of the changes in upper surface flow which were caused by the various leading-edge modifications, the chordwise pressure distributions and force and moment characteristics were also altered considerably.

A comparison is included between the measured pressure distributions and distributions calculated, assuming no flow separations to be present. This comparison demonstrates the desirability of employing a calculation method which allows for the effects of the "long bubble" separation.

Pulsation Damping in Pressure Gauge Connections

INDICATING TRUE MEAN PRESSURE

By T. J. WILLIAMS, M.Sc., Ph.D.*

In a previous paper,[1] the author examined the errors which may occur when a liquid manometer gauge is used to indicate the time-mean of a pulsating pressure or pressure differential. The requirements for the elimination of these errors were determined, and a form of liquid manometer gauge was proposed which would determine accurately the true time-mean of a pulsating pressure differential. This article is concerned with the same problem in relation to mechanical pressure gauges —that is, gauges which rely on the displacement produced in a mechanical part, such as a tube or diaphragm, when subjected to a difference in pressure. Examples of gauges of this kind are the Bourdon gauge, the Schaffer gauge, and the low-pressure gauges designed on the aneroid principle.

WHEN a mechanical pressure gauge is used to indicate the pressure in a duct leading to or from a source of pulsation, such as a reciprocating pump or compressor or a clattering valve, it is well known that the resultant oscillation of the gauge can soon result in permanent damage to the instrument. For this reason it is the usual practice for the gauge cock to be partly closed and used as a throttle valve to limit the amplitude of the pressure fluctuations at the gauge. It is perhaps not always realised that the resultant steady reading of the gauge pointer does not in general correspond to the true time-mean of the fluctuating pressure.

Neglecting for the moment the effect of wave action in the leads, if ΔP is the instantaneous pressure drop across the partly closed gauge cock, then the flow of fluid into the gauge will be proportional to

$$\pm(\pm\Delta P)^{1/n}$$

variations in fluid density and coefficient of discharge being neglected, the upper sign being taken when the fluid pressure being measured is instantaneously greater than that in the gauge. The value of n will be dependent on the internal geometry of the gauge cock, and will have a value between 1 and 2—nearer to 2 in most cases. In order to illustrate the errors which can arise when such a restriction is inserted in the connecting leads, consider a gauge being used to measure a cyclical fluctuating pressure in a liquid which has a value of 120 lb per square inch absolute for a quarter of the period T, and 80 lb per square inch absolute for the remainder of the period. Taking $n=2$, the steady gauge reading P_g lb per square inch absolute can be determined by equating the total inflow during the first part of the cycle to the outflow from the gauge during the remainder of the period. Thus we have in this case,

$$\frac{T}{4}\sqrt{(120-P_g)}=\frac{3T}{4}\sqrt{(P_g-80)}.$$

This gives $P_g=84$ lb per square inch absolute as compared with the true time-mean of $1/4\times120+3/4\times80=90$ lb per square inch absolute.

Viscous Damping Elements

If damping elements are inserted in the connecting leads in which the flow is laminar, then neglecting entry and exit losses which are dealt with later, the rate of mass flow W, through the resistor corresponding to a pressure drop ΔP would be given by an expression of the form

$$W=\frac{K}{\nu}\Delta P \quad . \quad . \quad . \quad . \quad . \quad (1)$$

ν being the kinematic viscosity of the fluid and K a constant for the element. Assuming that the resistance of the element is sufficient to damp out oscillations at the gauge, then if P is the variable pressure being measured, T the period, and P_g the steady gauge pressure, then since the net flow through the plug over a cycle will be zero,

$$\int_0^T \frac{1}{\nu}(P-P_g)dt=0 \quad . \quad . \quad . \quad . \quad (2)$$

In the case of liquid filled leads it would be possible in general to neglect variations in kinematic viscosity and then, from (2),

$$P_g=\frac{1}{T}\int_0^T P dt \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and the gauge would indicate the true time-mean of the pressure.

Where the connecting lead is gas filled, however, errors can arise due to variations in kinematic viscosity. As an example, assuming that the gauge is measuring a fluctuating air pressure pattern in which the pressure is 100 lb per square inch absolute and the temperature 100 deg. Cent. for half the period, and the pressure is 80 lb per square inch absolute for the remainder of the period. Assuming that the cyclical variations are related by the adiabatic equation $P/\rho^{\gamma}=$constant, and taking values of the absolute viscosity of air from Table 6 of B.S. 1042 : 1943,[2] it can be shown that the mean indicated air pressure will be about 90·5 lb per square inch absolute as compared with the true value of 90·0 lb per square inch absolute.

Effect of Connecting Lead Length

In the discussion so far, it has been implied that one side of the damping device is directly exposed to the source of pressure pulsation. In practice, the length of connecting lead between the source of pressure and the damping element can have a significant effect on the resultant gauge reading due to wave action in the connecting tubing. This is true in particular of gas-filled leads, and in the paper on liquid manometers mentioned earlier,[1] it was shown that the pulsation pattern at the gauge differed from the original pattern due to (*a*) variations in velocity of propagation with pulse pressure, (*b*) wave attenuation due to gas viscosity and wall friction, and (*c*) wave reflection at both ends of the connecting leads. Further, it was shown that errors could also result if there were any volumes or changes in section incorporated in the leads. As a result of the analysis, it was concluded that the length of gas-filled leads from the source of pulsation to the gauge should be as short as possible, and that they should be of uniform internal cross section. If it is not possible to keep the length of the gas-filled leads short, then it has been observed[3] that very long leads are preferable to intermediate lengths, and that a lead with a rough, elastic wall is best used in such cases due to its attenuating properties. In the case of liquid-filled leads, there would be no necessity to insert the resistor near the source of the pulsating pressure providing it could be ensured that the flow in the connecting lead was laminar in nature. There would, of course, be no restriction to the length of connecting lead between the damping elements and the gauge providing the resistance of the element were sufficient to damp out effectively the pressure fluctuations at the gauge.

Viscous Element Design

Consideration will now be given to the design of the viscous damping element itself. The use of damping elements consisting of plugs of fibrous or granular materials has been suggested, and while it has been demonstrated[3] that such elements can result in a substantial improvement in gauge accuracy, they do not provide a complete solution to the problem. The investigations of Fleming and Binder[4] of air flow through cotton wool and steel wool plugs showed that these materials exhibited a linear flow characteristic only for very small flows. Elements consisting of sintered glass discs and foamed plastic have also been shown to be unsatisfactory linear resistors.[3] It is therefore concluded that while such plugs are attractive from the point of view of ease of construction, and while they do result in some improvement in gauge accuracy, they are nevertheless unacceptable where a high degree of accuracy is called for. It is therefore proposed to examine damping plugs consisting of narrow parallel passages. If these are in the form of tubes of circular section, then flow equation (1) can be written in the form

$$W=\frac{\pi}{128}\frac{gd^4}{\nu}\frac{\Delta P}{L} \quad . \quad . \quad . \quad (4)$$

the Equation of Poiseuille, in which d is the tube bore and L the length of the passage, providing that the corresponding value of Reynolds number R_e given by

$$R_e=\frac{gd^3}{32\nu^2\rho}\frac{\Delta P}{L} \quad . \quad . \quad . \quad . \quad (5)$$

is sufficiently low.

In deciding on a suitable value for R_e, it has to be remembered that when a fluid flows from a region of non-laminar flow into a circular duct, a certain entry length is required before the parabolic velocity distribution associated with the equation of Poiseuille is established. Providing that the value of R_e for the flow through the tube is less than the critical value of approximately 2000, then normal viscous flow will be eventually established providing the entry length is sufficient. Even with a sub-critical R_e, it is probable that the flow at entry will be turbulent at the higher velocities. At very low values of R_e, however, it has been shown that flow will be laminar from entry—although the velocity profile will not be parabolic. In the case of water flow from a reservoir into a circular duct with a sharp entry, Naumann[5] concluded that flow would be smooth from entry whatever the disturbance in the reservoir providing that R_e was less than 280. The work of White and Davies[6] on flow between flat plates was in agreement with this and these experimental investigations were supported to some extent by the analytical work of Orr[7] who concluded that eddies cannot exist in a circular pipe when R_e is less than 180.

* University Reader in Mechanical Engineering, King's College, University of London.

Entrance Length

Attempts have been made to calculate the entrance length l_e necessary to ensure that a parabolic laminar flow is established. Boussinesq[8] appears to have been the first to examine this problem. His calculations were based on the assumption that entrance effects became negligible when the ratio of maximum to mean velocity is within 1 per cent of the normal value of 2. This analysis led to

$$l_e = 0{\cdot}065 R_e d \quad . \quad . \quad . \quad . \quad (6)$$

Schiller[9] obtained a similar expression for the entry length by assuming that the flow in the entry portion is unidirectional, and consists of a central uniform velocity core unaffected by friction bounded by a viscous resistance region with a parabolic velocity distribution, the wall velocity being zero. At entry the flow velocity is assumed uniform across the section, and at the end of the transition length, parabolic flow is assumed to extend across the section. The estimated entry length in this case was

$$l_e = 0{\cdot}02875 R_e d \quad . \quad . \quad . \quad . \quad (7)$$

Experimental investigation of the entry length by Nikuradse[10] was in good agreement with that predicted by Boussinesq in equation (6).

Using Schiller's assumptions, it can be shown that the pressure drop over the entry section is $1{\cdot}5 R_e^2 v^2 \rho / d^2 g$, as compared with $0{\cdot}92 R_e^2 v^2 \rho / d^2 g$ had the flow distribution been parabolic from entry. Since some of the additional entry pressure drop will probably be recovered at exit from the passage, it will be assumed that entry and exit effects are equivalent to adding about half the (Schiller) entry length to the total length of passage. Thus if the error due to entry and exit effects is of the order of x per cent, then we have very approximately,

$$\frac{x}{100} = \frac{l_e}{2L} = \frac{0{\cdot}015 d R_e}{L}$$

or,

$$\frac{L}{d} = \frac{1{\cdot}5 R_e}{x} \quad . \quad . \quad . \quad . \quad . \quad (8)$$

High-Frequency Pulsation

High-frequency pulsations can result in a breakdown of the normal parabolic velocity profile in the damping element with a consequent increase in the resistance-flow gradient. This was observed during the investigation of the behaviour of viscous flow meters under pulsating flow conditions reported in reference 3, where linear flow characteristics broke down at high frequencies although the value of R_e was low. It was suggested that the maximum allowable particle acceleration was dependent on the value of

$$\frac{Uv}{d^2}$$

where U was the mean velocity across the passage section. Since

$$W = \frac{\pi d^2 U \rho}{4}$$

then substituting for W from equation (4), it can be shown that the maximum allowable acceleration is dependent on

$$\frac{\Delta P}{L \rho} .$$

Thus in a given instance, the tendency for a breakdown of normal viscous flow to occur may be reduced by increasing resistance gradient of the damping passage.

Plug Diameter

It may be of interest at this stage to consider the application of the design equations to a specific pressure pattern. Considering the pattern mentioned earlier, where the pressure is 100 lb per square inch absolute for half the period and 80 lb per square inch absolute for the remaining half, it has been shown that an error can arise if the damping plugs contain a gas. It is therefore necessary to have the plugs and the connecting leads liquid filled. If water were used for this purpose, the kinematic viscosity ν at 15 deg. Cent. would be about $1{\cdot}14$ centistokes, or $1{\cdot}23 \times 10^{-5}$ square feet per second units. From the work referred to in this paper, it would appear necessary to keep Reynolds number less than about 200 if laminar flow is to be ensured throughout the damping plug. Taking R_e as 200, we have, on substituting in equation (5),

$$\frac{d^3 \Delta P}{L} = 1{\cdot}87 \times 10^{-6} \quad . \quad . \quad . \quad (9)$$

Also, if entry and exit losses are to be kept within, say, 1 per cent of the total plug drop, then we have from equation (8)

$$\frac{L}{d} = 300 \quad . \quad . \quad . \quad . \quad . \quad (10)$$

From equations (9) and (10) taking $\Delta P = 10 \times 144$ lb per square foot

$$d = 7{\cdot}4 \times 10^{-3} \text{in.}$$

A plug of this bore would obviously be too small in practice, and a liquid having a greater viscosity is therefore necessary in order to use a more reasonable bore. If the plug bore is to be about 0·03in, say, then it would be necessary to use a liquid having a kinematic viscosity of at least 5 centistokes. This would correspond roughly to the minimum viscosity of diesel oil. Larger plug bores could, of course, be used with oils of higher viscosities, and it would also be possible to lower the value of R_e. The latter would lead to the use of shorter plugs as indicated by equation (8).

Equations (5) and (8) thus enable the minimum diameter of the damping element to be calculated for a given pressure pattern and damping liquid. The actual diameter chosen will also be dependent on the volume and elasticity of the connecting leads between the plug and the gauge, the elasticity and capacity of the gauge itself, and the bulk modulus of the damping liquid. The relationship between liquid pressure and volumetric strain for the connecting tube can be determined by well-known methods given in textbooks on the strength of materials (e.g. Morley[11]). The corresponding relationship for the gauge could also be estimated by calculation, but it would generally be necessary to obtain details of the gauge construction from the manufacturers. Having done this, the maximum cyclical flow through the element could be estimated from equation (4) and hence the maximum variation in gauge pressure determined.

In many instances it would be preferable to determine the damping element and the gauge connection dimensions by trial and error, although it would be essential to check from equations (5) and (8) that the plug flow was laminar, and that entry and exit losses were negligible. Having done this the gauge damping could be conveniently varied by adjusting the length, bore and/or wall thickness of the connecting pipe between the plug and the gauge. Excessive damping is, of course, to be avoided since it would result in the gauge being sluggish. Also, any gas trapped in the gauge or connecting leads would have a very marked influence on gauge response.

Where the damping fluid is different from that in which the pressure is being measured, precautions have to be taken to avoid any loss of liquid from the leads. When measuring a gas pressure, for example, it would be necessary to have the connecting pipe sloping downwards from the point at which the pressure is being measured. It may be as well to repeat here the warning issued by gauge manufacturers that oxygen under pressure should not come into contact with oil.

Significance of Gauge Readings

Having indicated how a gauge can be installed so as to give a true time-mean of a pulsating pressure, it is often advisable to give some thought to the significance of the reading before using it in a given problem. For example, if such a gauge were connected to a tapping in the delivery pipe from a reciprocating compressor near the delivery valve, the gauge would indicate the true mean pressure at that point. But since the pressure pattern at this point includes pressures due to the residual pressure waves after valve closure, the mean reading obtained does not correspond to the mean pressure against which the compressor is pumping.

Another instance is where a pressure gauge is used in conjunction with a square-law flow meter, such as an orifice gauge. The pressure gauge can be designed to give the true time-mean of the pressure drop across the device when the flow is pulsating, but this does not enable the true mean flow to be determined. To do this it would be necessary to know the time-mean of the square root of the instantaneous pressure drop across the meter.

Conclusions

While mechanical pressure gauges can be protected from the destructive effects of pressure pulsations by inserting throttle plugs in the connecting leads, or by partially closing the gauge cock, the gauge indication will not in general correspond to the true time-mean of the pressure being measured. The use of viscous damping elements in the connecting leads will result in the true mean pressure being indicated, providing that :

(1) The length of connecting tube from the pressure source to the damping element is as short as possible, and of uniform bore.

(2) The damping element, the gauge and the connecting tube are filled with liquid.

(3) The maximum value of R_e for flow through the element is less than about 200 (from equation (5)).

(4) The length of the element is sufficient to ensure that entry and exit losses are small in comparison with the pressure drop across the plug (equation (8)).

Gauge damping can be adjusted not only by varying the design of the damping elements, but also by varying the length and/or section of the connecting pipe between the plug and the gauge.

Where pressure pulsations of very high frequency are present, a breakdown of the normal linear flow characteristic for the plug may occur even at very low Reynolds numbers. This can sometimes be prevented by increasing the resistance gradient of the damping element.

References

[1] Williams, T. J., 1956, *Trans. A.S.M.E.*, Vol. 78, page 1461.
[2] British Standard Code, B.S. 1042 : 1943, "Flow Measurement."
[3] Kastner, L. J., and Williams, T. J., 1955, *Proc. I.Mech.E.*, Vol. 169, page 419.
[4] Fleming, F. W., and Binder, R. C., 1951, *Trans. A.S.M.E.*, Vol. 73, page 621.
[5] Naumann, A., 1931, *Forsch. Ingwes.*, Vol. 2, page 85.
[6] White, C. M., and Davies, S. J., 1928, *Proc. Roy. Soc. A.*, Vol. 119, page 92.
[7] Orr, W. McF., 1907, *Proc. Roy. Irish Acad. A.*, Vol. 27, page 69.
[8] Boussinesq, J., 1891, *Comptes Rendus*, Vol. 113, pages 9 and 49.
[9] Schiller, L., 1922, *Zeitchr. f. angew. Math. u. Mech.*, Vol. 2, page 96.
[10] Nikuradse, J., 1934, *Applied Hydromechanics and Aeromechanics*, by Prandtl and Tietjens (first edition), page 25.
[11] Morley, A., 1941, *Strength of Materials*, Longmans, London. Ninth edition. Chapter X.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

WHY RESTRICT OUTPUT ?

SIR,—I would like to say how much I agree with the article by Antony Vickers, " Why Restrict Output ? " in the current issue of THE ENGINEER, and also, incidentally, with the letter by the same author on the same subject in THE ENGINEER of December 12, 1958. Of course, the comparison with Russia is not quite fair, since that country is so autonomous that it can proceed towards healthy economic expansion without having continuously to look over its shoulder, as it were, to watch nervously for the reaction on Big Brother's face. We, alas, are in just that position. Any move towards state enterprise is promptly branded as " Bolshevism." And it is just public enterprise that is required in a twentieth century economy.

When investment of a magnitude of £250,000 per man is needed, it is quite impracticable to leave such decisions in private hands. A private investor puts capital into an enterprise, not so much under the influence of actual conditions but of his expectations of future returns. Should he become disappointed, he will try to " cut his losses " and reinvest somewhere else. We have had ample experience of the disastrous ups and downs when a highly capitalised industry is left to the whims of private capital. As Keynes (who was anything but a " Red ") explained : the injection of purchasing power into, and conversely its withdrawal from, the national economy, according to the contraction or expansion of the private sector, would help to level out those booms and slumps. Inflation would thus be kept in check as well as deflation. The public sector would contain all the more highly capitalised industries which depend on long-term planning and investment, as well as industries through which the " multiplier " factor could take effect more quickly—public works such as road building, &c.

It is only surprising that America, which, after all, had gone through the worst of the recessions, and where the first Keynesian experiments were put into practice, has apparently thrown past experience to the winds. Eisenhower has stated quite explicitly (see the *Spectator* of February 21) that " sound money " must now have first policy priority, and with it all that this implies : restricted output and the express repudiation of full employment, in the interests of an outdated monetary policy. Over here this state of affairs has not quite been reached, thanks to a more articulate public opinion, but demands for greater unemployment (" in order to lubricate the economy "—by letting some of the oil run to waste) have been active for a long time and virtually, if not in so many words, full employment has been abandoned here, too, as a prime factor of social policy.

On the whole, I fear that the answer to the question in the last paragraph of the letter will have to be " No, we have learned nothing from Keynes "—or, if we have, we now prefer outdated theories. May we never regret it.

E. J. PORIES, B.Sc. (Econ.)

Wembley,
February 26, 1959.

SIR,—A clue to the question posed by Mr. Antony Vickers in his article, " Why Restrict Output? " lies in the failure of people generally to realise that there is an immutable order of priority in nature which, if flouted, will inevitably lead to destruction. It is that reality precedes abstraction—deeds precede words—facts precede the symbols which man eventually devised to describe them and to facilitate their manipulation.

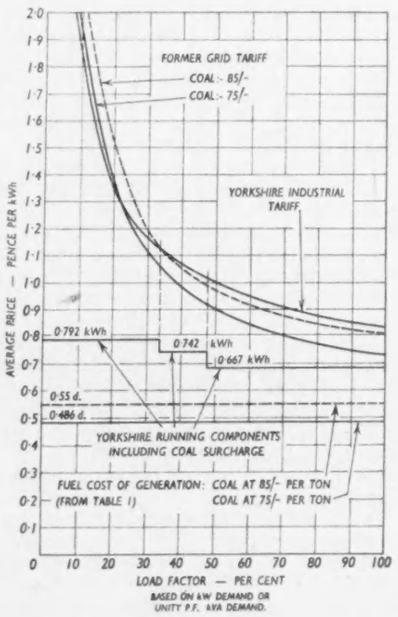
Money is a system of symbols—an ingenious and necessary system—which should be used to serve the orderly application of science for mankind's benefit. It is at present allowed to dominate life, which is an inversion of the natural order. Everywhere one can see facts being manipulated to fit figures—the closing of railways is an example—instead of the figures being adjusted to fit the facts.

W. A. WILLOX

Wootton,
Warwickshire,
February 25, 1959.

1959–60 GRID TARIFF AND OFF-PEAK ELECTRICITY SUPPLIES

SIR,—The article by S. B. Jackson in your issue of February 6 entitled " 1959–60 Grid Tariff and Off-Peak Electricity Supplies," gave an interesting account of some of the problems, but could mislead anyone unfamiliar with the subject. Perhaps the most interesting conclusion, however, was that the Yorkshire Electricity Board's tariff without its coal price adjustment was reasonable in encouraging industrial demand.


FORMER GRID TARIFF
COAL:- 85/-
COAL:- 75/-
YORKSHIRE INDUSTRIAL TARIFF
0·792 kWh
0·742 kWh
0·667 kWh
0·55 d.
0·486 d.
YORKSHIRE RUNNING COMPONENTS INCLUDING COAL SURCHARGE
FUEL COST OF GENERATION: COAL AT 85/- PER TON
(FROM TABLE I) COAL AT 75/- PER TON
AVERAGE PRICE — PENCE PER kWh
LOAD FACTOR — PER CENT
BASED ON kW DEMAND OR UNITY P.F. kVA DEMAND.

If the author has indeed persuaded the Yorkshire Board to drop the coal adjustment charge from their tariff, he will be congratulated by many of those whom he calls intelligent consumers, but if not, we must return to reality. In Table IV and Fig. 3, the Grid tariff with coal at 85s. per ton (adjusted for 11,000 B.Th.U. per lb) is compared with the Yorkshire tariff with no coal surcharge. For last year, the average cost of coal for the Yorkshire area was about 75s. per ton (adjusted). This gives a Grid unit charge of 0·568d. and the steps of unit charges on the Y.E.B. tariff at 0·792d., 0·742d. and 0·667d. Even the lowest step is thus well above the cost of generation given in Table I, with coal at 89s. per ton (adjusted to 11,000 B.Th.U. per lb) and even more so for coal at 75s. per ton. I have, therefore, redrawn Fig. 3 for coal at 75s. and the coal surcharge in the Yorkshire running costs. It may be argued that the comparison should be made with the Grid tariff based on the average cost of coal at 85s. per ton (adjusted), but I think we are concerned here with what the Area Board pays and charges. The Grid tariff is already framed so that the Generating Board can recover more from the high coal cost areas and so meet its overall fuel costs. I have, however, added a dotted curve for the Grid charges with coal at 85s. per ton (adjusted).

There are some further points about which I would like to comment. In Table I the estimates are based on coal at 85s. and 10,525 B.Th.U. per lb (or 89s. adjusted to 11,000 B.Th.U. per lb) and compared with Grid charges based on coal at 85s. per ton (adjusted). The new Grid tariff unit charge with coal at 89s. per ton (adjusted) would be 0·602d. instead of 0·575d. and, when compared with the actual cost as calculated in Table I, we find the balance to be 0·052d. and not 0·079d. per unit. Using the same figures as the author for the Grid generation —86,350M kWh and 22,340MW—the equivalent value of this balance is 16s. 6d. per kilowatt instead of £1 5s. 3d. This is considerably less than the increase of £1 2s. 0d. in the M.D. charge of the Grid tariff and confirms that the new M.D. charge is being made to carry a share of the fuel cost of generation. Incidentally, it is not necessary to introduce a diversity factor for the Area Boards' aggregate maximum demand on the Grid. In putting forward 22,340MW as the nominal aggregate chargeable M.D. for the Area Boards, the Grid tariff provides for an adjustment of M.D. charges if the actual simultaneous demand varies by more than 1 per cent from the nominal.

In Table V, where an attempt is made to assess a fair night off-peak tariff based on " the actual costs incurred in production and transmission," the cost of generation with coal at 85s. per ton (10,525 B.Th.U. per lb) is compared with the last component of the Yorkshire tariff, again without the coal surcharge. For the Yorkshire area, with coal at 75s. (11,000 B.Th.U. per lb) the realistic

basis proposed would give a unit cost of 0·535d. per unit instead of 0·625d. The lowest step of the Yorkshire tariff (with coal surcharge) is still 0·667d. per unit, so that the industrial consumer who elects to use off-peak power would pay 25 per cent above the real cost of producing the supply, or 11 per cent above the average cost with coal at 85s. per ton (adjusted) instead of 12 per cent below.

Average costs do not tell the full story, although they may disguise, for large consumers, the effect of premium charges for maximum demand and unit rates. The average efficiency of transmission quoted, 85·5 per cent, is not a fair figure for bulk off-peak industrial power. Generating stations are built where fuel can be obtained cheaply. A consumer may have to go to trouble and expense to build his factory where power could be cheap and to schedule his production accordingly. If he is prepared to do so, an electricity tariff, framed to encourage such use of off-peak power which might not otherwise be used at all, should be available. There is a feeling nowadays that because cheap off-peak power is not attractive to everybody, most of whom cannot use it, it should not be available to the few who could.

In discussing the economic basis for the tariffs based on the actual costs of generation during off-peak periods, the author is apt to fall back on "other factors which are necessarily taken into account in framing a tariff" or "practical considerations," &c., which seem to belong more to the tariff-maker's art than to economics. More emphasis should have been given to the difference in the actual economic costs of supplying the high load factor industrial load which works round the clock, and the intermittent night loads such as storage heaters. If the best use is to be made of the generating and transmission plant, a better balance between day and night maximum demands is needed. A separate problem is to encourage entirely new high load factor heavy industrial consumers. As a beginning, the Area Boards might abolish the premium elements in the high cost steps in the maximum demand charges and unit rates for medium and large loads maintained at more than 50 per cent load factor over the year.

E. R. FREEMAN

McLellan and Partners,
32, Victoria Street, Westminster,
London, S.W.1.
February 27, 1959.

THE USE OF NON-DIMENSIONAL GROUPS

SIR,—In a pair of papers in your journal Engel[1, 2] has proposed a classification of non-dimensional groups in terms of their usefulness in process engineering. The dominant feature of this classification, and the one for which the author may be justly congratulated, is the insistence on the physical significance both of derivation of the dimensionless groups used and of the limitations on the handling of the groups so derived. In this latter respect, however, it appears necessary to remind the author that any single mathematical combination of numbers, sums, products, &c., can never give the same amount of information as the array of numbers themselves. Further the limitations proposed on the derivations of dimensionless groups may be too rigid and would restrict the applications to this method in other promising fields.

In all but the most trivial applications to model theory some of the descriptive dimensionless groups (as indeed noted by Engel) are mutually inconsistent. In such cases we may set up only conditions for partial similarity. The usefulness of a partial model and whether or not it gives a reasonable approximation of the system studied depends upon whether or not the physical properties selected to define the dimensionless groups exert a dominant or minor effect on the system. This in turn can only be decided by reference to the basic equation of equilibrium of the system. Let us look, therefore, at some of the restrictions asked by Engel for "genuine non-dimensional groups of dynamic similarity" in relation to the equations of equilibrium.

Some of the restrictions asked by Engel include :

(*a*) Genuine non-dimensional groups should include a velocity term.

(*b*) The dimensionless group of properties of a substance and the ratios of two quantities of the same nature which he terms dimensionless parameters should not be included.

(*c*) Irreversible processes in which dependent and independent groups are distinct only should be considered.

(*d*) The use of integral exponents only is postulated.

(*e*) The system is based on three fundamental dimensions of m, l and t or alternatively on v, l and ρ.

The stream velocity may be a dominating property in problems of similarity in process engineering. However, dimensional methods have been applied to many other fields. In some of these the stream velocity may either be a minor variable or even a meaningless quantity. Examples occur in applications to fundamental physics (Guggenheim[3]), to the analysis of chemical kinetics (Frost and Pearson[4]), to the theory of capillarity (Bashforth and Adams[5]), to the analysis of scale effects in chemical reactors (Bosworth[6]) and to many others.

In many of these systems too the absolute distinction between cause and effect disappear and accordingly there is no absolute distinction between dependent and independent variables and thus no cause to eliminate one particular group from conditions of similarity because that group could have contained a dependent variable.

Rigid insistence on a system of three fundamental dimensions in dynamical systems (and presumably four in thermal systems) is not in accord with the opinions of those who have given thought to the philosophical aspects of dimensional theory. Dingle,[7] for example, states that the number of fundamental dimensions in any system is purely arbitrary. Johnstone and Thring[8] use alternative systems in thermal problems with either four or six fundamental dimensions. In certain cases the systems with a larger number of fundamental dimensions lead more rapidly and easily to the desired results.

In the relationships between physical variables there occur a number of experimental constants : $\frac{1}{2}$, $\frac{1}{4\pi}$, J the Joule's equivalent, R the gas constant, c the velocity of light, α the fine structure constant and many others. These may either be regarded as purely numerical quantities or as constants of nature of a dimensional character which may be defined as the equations in which they occur. Thus in the equation

$$\text{Work done} = J \times \text{Heat generated},$$

if we regard work and heat being dimensionally equivalent the constant J is dimensionless. However, if we regard J as a dimensional constant of nature the dimensions of Q become

$$Q = ml^2t^{-2}J^{-1}.$$

Conversely there are many equations in fundamental physics where c the velocity of light occurs. If we regard c as a purely numerical quantity then the dimension of time and length become the same and dynamic systems have but two fundamental dimensions, thermal systems but three.

An easy derivation of the total number of fundamental dimensions appropriate to any system can always be referred to the equation of equilibrium of the system. This may always be cast in the form

$$A+B+\ldots.+N=0 \quad . \quad . \quad . \quad (1)$$

with n terms. Each term may involve numerical quantities, constants of nature and functions, powers or products of physical variables. The functions may either be algebraic, differential or integral. Each term in equation (1) may be associated with a definite dimension and thus measured as a definite unit. Conditions for universal validity for the equation require that each term shall have the same dimensions. Otherwise the validity of the laws of nature could be changed by a mere change in the units of measurement. Since equation (1) is dimensionally homogeneous, then

$$\frac{B}{A}+\frac{C}{A}+\ldots.+\frac{N}{A}=-1 \quad . \quad . \quad (2)$$

is an equation of $n-1$ terms in dimensionless quantities. Alternatively

$$\frac{A}{B}+\frac{C}{B}+\ldots.+\frac{N}{B}=-1 \quad . \quad . \quad (2a)$$

is an equivalent dimensionless equation in $(n-1)$ dimensionless terms of which $(n-2)$ are different from those of equation (2).

If there are k dimensional properties, including dimensional constants, differentials and integrands in the n terms of equation (1) then the dimensions of the $n-1$ terms in equation (2) may be selected in $k-(n-1)=k+1-n$ arbitrary ways. The system thus has $k+1-n$ fundamental dimensions. If one of the numerical quantities is now to be regarded as a dimensional constant the value of k and thus of the number of fundamental dimensions in the system is increased by unity. Conversely reduction of the status of a constant of nature to a pure number will reduce k by unity.

Thus the equation for the conservation of energy in a flowing fluid with the conduction and convection of heat and its generation by friction leads to

$$\frac{\partial}{\partial_t}(C\rho\theta) = -\operatorname{div}(C\rho\theta v) + Jv \operatorname{grad} P + k\nabla^2\theta \quad . \quad . \quad . \quad . \quad . \quad (3)$$

with the following properties

t—The time.
$(C\rho)$—Heat capacity per unit volume (a single property in this example).
θ—The temperature.
div and grad—Space operators of dimension L^{-1}.
∇^2—Space operator of dimension L^{-2}.
v—Velocity.
J—Joule's equivalent.
P—The pressure.
k—The thermal conductivity.

There are four terms in equation (3) and seven dimensional properties. There are therefore four fundamental dimensions. However, should we regard J as a dimensional quantity k becomes eight and there could be five fundamental dimensions.

Let us now come back to the requirements asked by Engel. His first request is for a velocity term in every dimensionless group. This is equivalent to the act of using the inertial term as the common denominator in deriving dimensionless groups. If B is the inertial term in equation (1) then the scheme proposed by Engel would regard the groups in equation (2*a*) as genuine dimensionless groups and those in (2) as not genuine. This seems too arbitrary. Further in the description of the state of equilibrium for certain systems such as those of a chemical nature, terms of an inertial form may either exert a negligible effect on the system or may be absent altogether. In such cases it would be quite wrong to seek laws of similarity based on dimensionless groups involving a velocity term. Again many systems—an example is provided by the study of heat transfer in a moving fluid considered in Engel's second paper—involve a series of equations of equilibrium. From these particular equations a series of formally similar, different dimensional groups may be derived with the replacement of one particular property by another dimensionally equivalent property or group of properties. In the analysis referred to above two such dimensionless groups ; the Reynolds and the Péclet Numbers arise from the system property group vl and the dimensionally equivalent ρ/η for the Reynolds Number and $C\rho/k$ for the Péclet Number. If laws of similarity are to be set up between systems on different scales of geometrical magnitude then both the Reynolds and the Péclet Numbers can both be equated for model and prototype if, and only if, the Prandtl Numbers are the same. The Prandtl Number is a purely internal ratio of physical properties and thus would, I gather, not be regarded by Engel as a genuine dimensionless group. Further again had the system concerned involved diffusive phenomena a new dimensionless group of the same status of the Reynolds and Péclet Numbers, namely

$$vl/D,$$

with D the diffusion coefficient, would arise. Had the system the capacity for producing foam perhaps another equivalent group

$$vl\Gamma/\tau_{is},$$

with Γ the surface adsorption per unit area and η_s the surface viscosity would again arise. The simultaneous satisfaction of conditions of equality for any two or more of these groups of Reynolds-like numbers could only be attained if certain internal dimensionless groups can also be equated. In the event of such conditions being mutually inconsistent it will be possible only to establish conditions of partial similarity. Whether or not the Reynolds or the Péclet group (or any other equivalent property) should be most effective as an index for partial similarity will depend on whether the terms used from the equations of equilibrium are dominant or minor variables of the system.

Again there are no intrinsic reasons why all the exponents of powers occurring in equation (1) should be integers. It is indeed a fact that fractional indexes tend to appear in the less extensively developed sciences. Many examples thus occur in the integralist approach to rheological phenomena (Scott Blair[9]). Indeed it has been considered desirable to define fractional differential coefficients (Scott Blair *et al*[10]) to meet cases of this nature. It would seem therefore that non integral dimensional systems, even if not desirable on the basis of epistemological order, appear to be helpful at some early stages in the growth of new sciences and technologies.

Briefly then we may summarise the position that methods of similarity may be useful in the analysis of models. Where however the conditions for the partial balancing of different aspects of the system concerned are inconsistent then guidance for the most helpful design and most reasonable approximation can only be referred in principle to a more fundamental study of the system concerned, and not to any particular code for the manipulation of the dimensionless quantities used to describe conditions for similarity.

R. C. L. BOSWORTH

Associate Professor, Head of the Department of Physical Chemistry.

University of New South Wales,
Australia,
January 27, 1959.

REFERENCES

[1] F. V. A. Engel, THE ENGINEER, page 637 (1954).
[2] F. V. A. Engel, THE ENGINEER, pages 479–484 (1958).
[3] E. A. Guggenheim, *Phil. Mag.*, 33, pages 479–496 (1942).
[4] A. A. Frost and R. G. Pearson, "Kinetics and Mechanism," John Wiley and Sons, Inc., New York (1953).
[5] F. Bashforth and J. C. Adams, "An Attempt to Test the Theories of Capillary Action," C.U.P. (1883).
[6] R. C. L. Bosworth, "Transport Processes in Applied Chemistry," pages 303–325, Horwitz, Sydney (1956).
[7] H. Dingle, *Phil. Mag.*, 33, pages 321–341 (1942).
[8] R. E. Johnstone and M. W. Thring, "Pilot Plants and Scale Up Methods in Chemical Engineering," McGraw Hill, New York, (1957).
[9] G. W. Scott Blair, "A Survey of General and Applied Rheology," Pitman (1944).
[10] G. W. Scott Blair, B. C. Veinglon and J. E. Caffyn, *Proc. Roy. Soc.*, A189, page 69 (1947).

Books Received

Bonded Aircraft Structures. CIBA (A.R.L.), Ltd., Duxford, Cambridge. Price 52s. 6d.

Visual Problems of Colour. Volumes 1 and 2. H.M. Stationery Office. Price 42s. for two volumes.

Applied Mechanics. By J. A. Cormack. Chatto and Windus, Ltd., 40-42, William IV Street, London, W.C.2. Price 30s.

Atomic Terminology. By Lore Lettenmeyer. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 42s.

The Design of Physics Research Laboratories. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 21s.

Mobile Radio Telephones. By H. N. Grant. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 21s.

Linear Structural Analysis. By P. B. Morice. Thames and Hudson, 30, Bloomsbury Street, London, W.C.1. Price 35s.

Principles of Automatic Controls. By F. E. Nixon. Macmillan and Co., Ltd., St. Martin's Street, London, W.C.2. Price 30s.

Book Reviews

Time Measurement. By F. A. B. WARD, M.A., Ph.D., F.B.H.I. Science Museum, South Kensington, London, S.W.7, and H.M. Stationery Office, York House, Kingsway, London, W.C.2. Price 5s. 6d.

THE fourth edition of this instructive handbook has been revised and brought up to date by the inclusion of necessarily brief, but quite informative, descriptions of the most recent developments in time measuring devices, such as the quartz-crystal and atomic clocks. This is a useful step, for, as with most of the handbooks of the Science Museum, *Time Measurement* forms, if not an introduction, yet still an important stage in the instruction of those who have become interested in the science of horology.

The earlier chapters of the book, have been but little altered, though slight modifications, arising from the removal of the Royal Observatory from Greenwich to Hurstmonceaux, and the introduction of the atomic clock, have been made at the appropriate places. The equation-of-time diagram in this part of the book has been improved by redrawing, and a new diagram, in the form of a chart showing the progress made in the accuracy of timekeepers, has been added.

In the section dealing with mechanical clocks, care has been taken to include a summary of the results of the research work into the history of a number of early examples since the previous edition appeared. This part of the book is now more complete and accurate, though no mention is made of the old "upright frame" clocks which have attracted considerable attention since the discovery of the important movement of this type in Cotehele House, Cornwall.

Mention is made of the recent restoration of the ancient clock in Salisbury Cathedral, but the fact that the movement is now exhibited at work is not made clear. As this clock is probably the oldest still at work in England, if not in the whole world, this omission seems unfortunate, as does the inclusion of the illustration that appeared in the earlier editions, showing the mechanism in an unrestored condition. A good view of the clock as it is at present would have seemed to be more appropriate, and would have given the reader a better idea of the construction of fourteenth-century clock movements.

In dealing with the introduction of the pendulum and its application to the clock, the text has been partly rewritten to give the story of this very important advance more precisely, and the part played by Christiaan Huygens is deservedly dealt with in more detail.

Tower clocks form such a large and distinctive aspect of horological construction that it is somewhat disappointing to find them described in a few sentences, and their structural developments, such as the change from the "birdcage" to the flat-bed frame, entirely ignored. Then, too, no indication is given that the modern developments, such as automatic winding and impulse control, are dealt with in a later part of the book. The invention of the gravity escapement, which was one of the greatest advances in precise timekeeping for large clocks, is briefly mentioned, but no illustration of it is given. But little is said about the great Westminster clock, which still remains the most famous clock in the world.

In the chapter on watches and spring-driven clocks, mention has been included of the "cross beat" escapement, a peculiar form designed to give better timekeeping than the

verge. The invention by George Graham of the cylinder escapement, and, later, by Thomas Mudge, of the lever escapement, are both mentioned, but the descriptions are distinctly sketchy, and no illustrations are given.

New sections in this chapter deal with methods of regulation used for watches and spring-driven clocks using balance escapements, and with winding devices.

In describing winding mechanisms, credit is rightly given to British horologists for the invention of the automatic, or swinging weight, method of winding. It is good to have this point made clear, for the extensive use of this mechanism by Swiss makers during recent years has led to the assumption by many people that they also invented it.

The chapters on chronometers and Japanese clocks remain unaltered, as does the chapter on electric clocks, except that the final paragraph appearing in earlier editions, which mentioned the special design of electric clocks for use on supply mains that are prone to failure, has been deleted. This seems rather a pity, for, despite improvements in recent years, public supply mains are by no means exempt from failure. In addition, the important fact that frequency variations will cause a clock, though still going, to show incorrect time, does not seem to have been made sufficiently plain.

The quartz crystal and atomic clocks each have chapters to themselves, but both are very brief, and could, with advantage, be expanded. The final paragraphs of the section on chronographs have been modified to include the application of the high-voltage cathode-ray tube to chronographic work. Mention is also made of the electronic stop watch, controlled by a quartz oscillator.

In the list of reference books at the end of the handbook, it is a little disappointing to find that no book later than 1956 is included, for several most useful works have been published since that date.

Aircraft and Missile Propulsion. Volume I. By M. J. ZUCROW. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 92s.

THE engines of to-day are the result of a continuous process of development and refinement over many years. All too often, practice has overtaken theory, although we tend to regard the reverse as normal. To present a comprehensive technical background of the many engine configurations now common is a mammoth task, and it is not surprising that Mr. Zucrow has decided that he requires more than one volume to cover the field. Volume No. I, which is the first of a trilogy, bears the sub-title " Thermodynamics of Fluid Flow and Application to Propulsion Engines " and sets out to give a comprehensive review of the fundamental principles of thermodynamics applied to propulsion. In many ways it is highly successful ; in others one gets the impression that the author has tended to expand the subject rather excessively.

The various chapters deal with the general characteristics of propulsion systems, the thermodynamics of compressible fluid flow and the flow through nozzles and diffusers. The material used is clearly presented with copious diagrams and should be very helpful to those who have the time to give to such a comprehensive work. Others may well find that some of the material does not in fact really form an essential part of the background required for their thermodynamic activities.

There are some detailed points of criticism which one may make. Thus, on page 30 the equations 1.34 and 1.35 are self-explanatory, but the words between the equations seem to bear little relation to the equations. Similarly, on page 87 there appears to be some confusion between the text and one of the very many excellent worked examples which are sprinkled throughout the book. It is difficult to understand why an explanation on the commutative and distributive properties of scalar products should appear in the middle of an example. Incidentally, these examples should be of very great value to the engineering student at University level.

On page 81 there is what most engineers will find a most unexpected statement in connection with the basic laws of motion. It is difficult to understand why a book of this type should contain the paragraph " According to Einstein, the mass m is given by

$$m = \frac{m_0}{\left[1-\left(\frac{V}{c}\right)^2\right]^{1/2}}$$

where m_0 is the mass of the body at rest and c the speed of light. It is apparent from the above equation that, unless V is of the same order and magnitude as c, the mass m may be assumed to be constant, an assumption that is justified for engineering purposes." Although, of course, one can hardly dispute the content of this passage, it does represent an unwarranted intrusion into the realms of atomic physics which one can only presume was not intended to be covered in connection with propulsion systems.

The copious references provided at the end of each chapter should prove of great value to those who wish to take their studies further, although one imagines that a three-volume work on this subject will leave very little room for the student (other than the very extreme specialist) or practising engineer, to pursue the matter.

Annual Report for 1957 of the European Federation of Corrosion. Published by the General Secretariat of the European Federation of Corrosion (Frankfurt Office). Frankfurt/M. : Frankfurt Office of the General Secretariat of the European Federation of Corrosion, Frankfurt (Main), 7, Postfach. Price for members of affiliated societies, DM.15, for non-members DM.30.

THE development of the European Federation of Corrosion, an association of European technical and scientific societies concerned with research on corrosion and the protection of structural materials, has continued satisfactorily during 1957. The Federation consisted of thirty-two societies from nine countries at the time of its formation in 1955, and by the end of 1957 the number of members had increased to forty-eight societies from fifteen countries. Part I of the report deals with the work of the Federation as such. Following a further expansion, the Scientific Advisory Council now consists of one or two outstanding experts from each of ten European countries. The organisation of the second Congress of the European Federation of Corrosion, which took place from June 5 to 8, 1958, within the framework of the European Congress of Chemical Engineering in Frankfurt (Main), was undertaken by the Deutsche Bunsen-Gesellschaft für physikalische Chemie and the Gesellschaft Deutscher Chemiker. The successful results of this congress have been fully reported in the home and foreign technical Press. The activities of member societies of the European Federation of Corrosion are fully reviewed in Part II.

Part III of the annual report provides a survey covering a wider field than that of 1956 of the research institutes in Europe which are engaged in the investigation of corrosion and the protection of materials.

Obituary

W. J. PICKEN

WE have learned with regret of the death, on February 24, at the age of seventy-two, of Mr. W. J. Picken, a former engineer-in-chief of Marconi's Wireless Telegraph Company, Ltd., and since 1953 Technical Consultant to the English Electric Valve Company, Ltd.

Mr. Picken joined Marconi's Wireless Telegraph Company, Ltd., in 1913, and from 1914–18 was engaged with Captain H. J. Round on the direction finding and interception network set up for anti-U-boat operations. He was transferred to the research staff of the Marconi company in 1919 and was engaged on valve development work until 1928, when he was appointed Valve Controller.

In 1935 he became Deputy Engineer-in-Chief and later Engineer-in-Chief, a position with which he combined that of general manager from October, 1938, to 1940. After liaison work in Canada and the U.S.A. in the early years of the second world war, Mr. Picken, in 1943, was, at the Admiralty's request, seconded to the Department of Scientific Research and Experiment, where he worked with Dr. J. H. E. Griffiths in C.V.D.—the department responsible for the development of all valves for defence purposes. In October, 1946, he retired from the post of Engineer-in-Chief to Marconi's Wireless Telegraph Company, Ltd., and succeeded Dr. Griffiths as Secretary to C.V.D.—a post he held with distinction until he retired from Admiralty service in April, 1953. For his work in this capacity he was awarded the O.B.E. in 1950.

Mr. Picken was for many years a member of the Technical Committee of the British Valve Manufacturers' Association. He became a Member of the Institution of Electrical Engineers in 1935 and for the 1940–41 session was Chairman of its Wireless Section Committee.

R. A. JOHNSON

WE regret to record that a road accident near Daventry on February 22 caused the deaths of Mr. R. A. Johnson, A.R.Ae.S., and his wife.

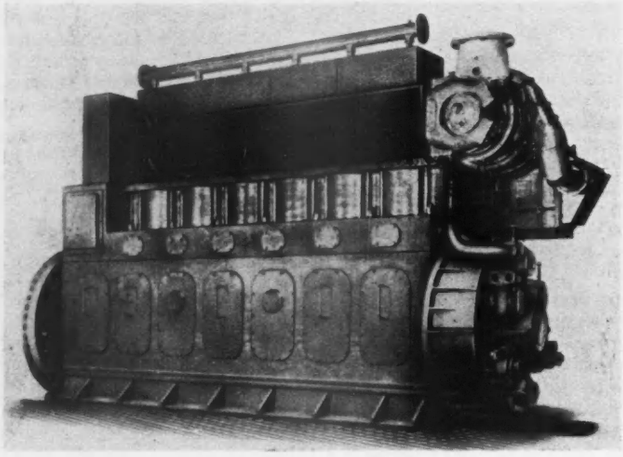
Reginald Arthur Johnson was born in 1915 at Coventry and served an apprenticeship at Sir W. G. Armstrong Whitworth Aircraft, Ltd., Baginton. He later joined the planning department of the Rover Company, Ltd., and went to CIBA (A.R.L.), Ltd.—then Aero Research, Ltd.—in March, 1949, to develop sales of the company's products in the aircraft industry. He travelled extensively for the company on the Continent as well as to more distant parts, including Japan and U.S.A.

Mr. Johnson was a Freeman of the City of Coventry, an Associate of the Royal Aeronautical Society and a member of the committee of the Cambridge branch of the Society.

Ruston "AT" Diesel Engines

During the last few years Ruston and Hornsby, Ltd., has been engaged in preparing a range of diesel engines of completely new design in which the stresses in all main structural members were analysed. The new engines have been given the mark "AT" and are either turbo-charged or turbo-charged and intercooled: they are available as industrial or marine units having five, six, seven, eight or nine cylinders and a power range of from 622 b.h.p. to 1645 b.h.p.

BEFORE the war four medium speed vertical engines having bores ranging from 8in to 15in were introduced by Ruston and Hornsby, Ltd., and since 1945 the range has been extended to include a 17in bore engine and to give a coverage from 100 h.p. to 2410 h.p. During the following years the soundness of the basic concept of these engines enabled the design to remain unchanged with considerable advantage from the point of view of standardisation. This overall position has made it possible to make an unhurried review of the changing demands for power as dictated by expanding markets and the industrial development of other countries. This review of long-term trends of engines of over 600 b.h.p. was commenced about five years ago and a study of the relevant factors culminated in the decision to prepare a specification for a completely new engine range which has been given the mark "AT." The approach to the problem was based on the engines being turbo-charged with provision for intercooling and having ample margin for development to utilise the highest brake mean effective pressure.



"AT" diesel engine with front end cover providing six auxiliary drives

In formulating the specification and developing the design there has been a considerable amount of new thinking and a careful examination of existing knowledge to establish technical reasons for current practice. Although changes have not been made just for the sake of change, nevertheless, they have been made where modern techniques and methods of stress analysis indicated the need for modification. Fundamental problems have been examined and new ideas have been developed and tested to establish their practicability and the advantages which they may effect. Such a detailed study has been made possible by employing an electronic computer which reduced the time taken for a calculation from hours to the corresponding number of seconds. With this aid it has been possible to compute the effect of a number of independent variables, such as: boost pressure ratio; intercooler outlet temperature; engine compression ratio; maximum cylinder pressure; trapped air/fuel ratio; engine expansion ratio, and scavenge air excess. Specific fuel consumption, brake mean effective pressure, exhaust temperature and scavenge pressure drop, were determined by each calculation and plotted on a series of three-dimensional graphs, using certain fixed items as a basis. From these graphs it was possible to assess the effect on performance of variations in the independent factors already noted. Over 6000 calculations provided the basis of the operating cycle for the "AT" engine and showed how to achieve the optimum fuel consumption within the set limits of maximum cycle pressure and brake mean effective pressure. Prototype six- and eight-cylinder engines have been mainly run at up to 160 lb per square inch brake mean effective pressure and a fuel consumption, conservatively assessed, of 0·34 lb per brake horsepower per hour has been consistently obtained on test.

Engine Particulars

As finally determined, the "AT" engine is a four-stroke direct injection unidirectional unit with a bore and stroke of 12½in by 14½in, giving a swept volume of 1785 cubic inches and a piston speed of 1200ft per minute at 500 r.p.m. The turbo-charged engine has a brake mean effective pressure of 125 lb per square inch and a maximum cylinder pressure of 1000 lb per square inch, the corresponding figures for the intercooled unit being 160 lb and 1200 lb per square inch. Fuel is injected at 2500 lb per square inch and the following are the bearing dimensions: main bearing, 10½in diameter by 5¾in long; large end 9½in by 5¾in, and small end 5½in by 4⅞in. Five-, six-, seven-, eight- and nine-cylinder engines are to be produced for both turbo-charged and turbo-charged and intercooled versions of industrial and marine power units. Industrial engines have the mark "ATX" and "ATC" for the respective designs, while the marine engine is indicated by the addition of the letter "M" as follows: "ATXM" and "ATCM." Below are the performance curves for both sets of marine engines.

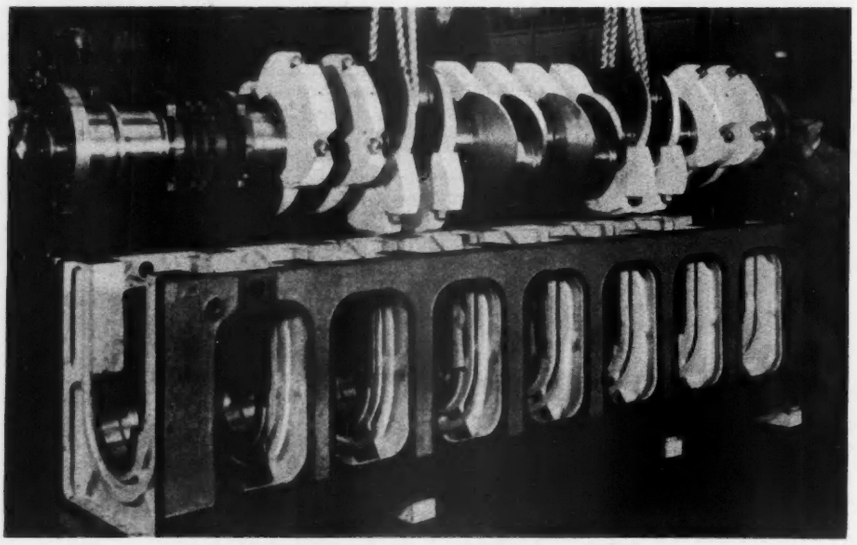
The following table gives the recommended continuous shaft horsepower at the gear-box output coupling.

Number of cylinders	Continuous s.h.p. at 500 r.p.m.	
	ATXM	ATCM
5	622	793
6	756	950
7	869	1112
8	997	1273
9	1120	1420

The accompanying illustration gives a general external view of a six-cylinder engine, fitted with a self-contained drive assembly, and our line drawing shows a sectional arrangement of an "AT" marine unit.

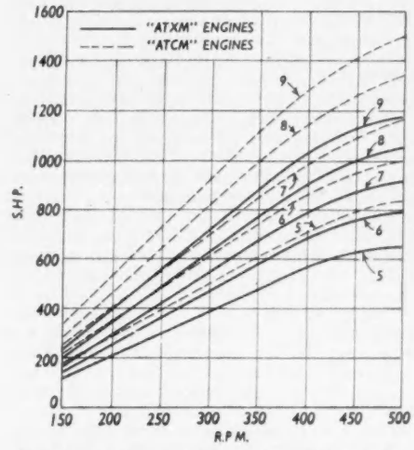
The turbo-charged industrial units range in power from 715 b.h.p. to 1280 b.h.p. (B.S. rating), the corresponding figures for the turbo-charged and intercooled engines being 910 b.h.p. to 1645 b.h.p., both at 520 r.p.m.

Among the more important items of design incorporated in the engine are the adoption of a rigid crankcase, seen in our illustration, together with the crankshaft, to assist alignment and provide dimensional stability of a



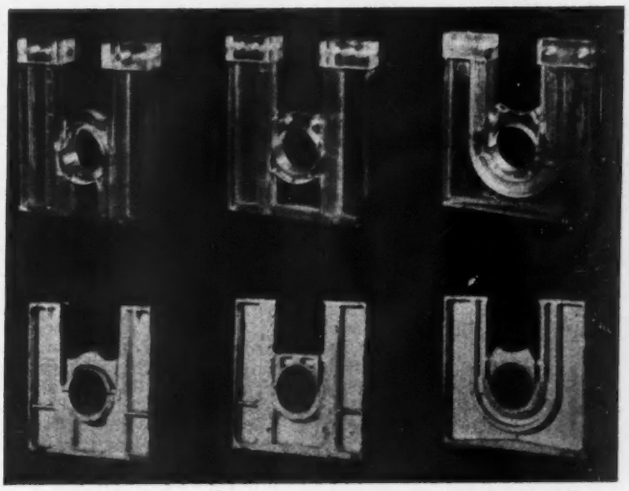
Crankshaft and crankcase of a six-cylinder Ruston "AT" engine

high order for the main bearings. The cylinder block casting is strongly resistant to torsion and bending and the geometry permits the cooling system to be operated under pressure if required. Effective cooling of the upper part of the liner is ensured by the arrangement for transferring cooling water from the cylinder block to head and higher rates of heat transfer are possible by the increased scrubbing velocity of the water. Another major item was the development of a four-stud cylinder attachment which gave good gasket sealing and also permitted the adoption of the optimum shape of air and exhaust ports. The design allowed fully for the stress-flow pattern between studs, cylinder head and cylinder block and in a hydraulic test the cylinder head joint withstood a pressure of 3000 lb per square inch, which is considerably more than the 1200 lb per square inch which is the maximum firing pressure expected in the " AT " engine.



Performance curves of " ATXM " and " ATCM " marine diesel engines

Dimensional stability of main bearings was investigated, and by means of "Perspex" and silicone rubber models (illustrated herewith) it was possible to gain knowledge of the effect of loadings and so evolve a main bearing support which gave the required degree of stiffness. This analysis of a structural member led to the process being applied to all important parts and resulted in modifications being introduced in the production engines. Castings have been simplified in design and overall size kept to a minimum, so that moulding time has been reduced and also the scrap rate. The engine consists largely of castings and welding of the crankcase was not adopted mainly on account of alignment costs; however, the cam box, of which the lower part forms the air chest, is of fabricated construction.



" Perspex " and silicone-rubber models used in investigation into deflections under load of main bearings of Ruston " AT " engine

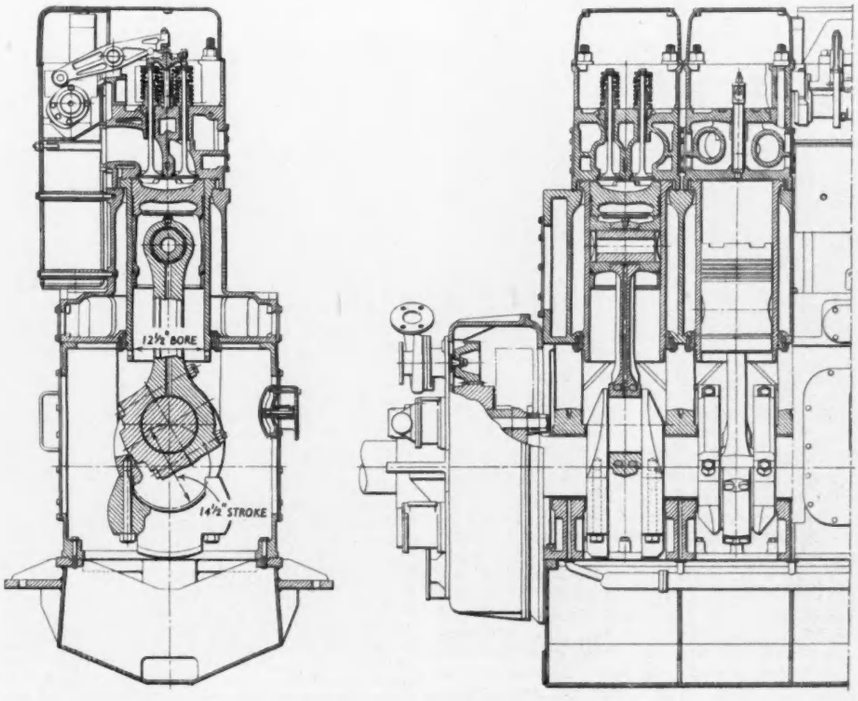
General Specification

The crankcase and cylinder block are rigid castings with the bearing seats and caps embodied in the crankcase, the caps being located by a serrated joint. Large access doors to the crankcase are fitted with B.I.C.E.R.A. pattern explosion valves and the cylinders have honed wet cylinder liners. Separate cylinder heads carry a multi-hole fuel injector, air starter valve and a relief valve, and two inlet and two exhaust valves. The latter, which seat in renewable inserts of austenitic cast iron, are of EN 52 material, have stellited faces and are interchangeable. The valves are operated by a rocker arm having at one end a wrapped bush in direct contact with the cast iron cams, which are secured to the camshaft by cotter pins. A chain from the crankshaft drives the camshaft and is fitted with a tensioner which permits adjustment without affecting valve timing.

Cast iron is used for the pistons which have a shallow bowl-shaped crown and three pressure, one triple-seal and two scraper rings. In engines with intercooling the pistons are oil cooled. The forged steel connecting-rods have caps located by serrations and are fitted with chilled bronze small end bush and twin steel-backed aluminium-tin bearings. Similar bearings carry the forged steel crankshaft formed by the " Continuous Grain Flow " process and fitted with balance weights providing 97·5 per cent compensation for rotating forces and having a frequency high enough to obviate the need for a torsional vibration damper. The bed-plate is fabricated and incorporates the oil sump.

There is a separate oil fuel pump, of Ruston design, for each cylinder, controlled by a centrifugal governor through a hydraulic servo-mechanism. Dry sump lubrication and a sea water circulated cooler are fitted in the marine engine, while the industrial unit has a wet sump system and an oil cooler cooled from the main engine system. Efficient cooling is effected by a closed forced circulation system, in which an integral centrifugal pump comes into operation with the starting of the engine, and the water is cooled in a heat exchanger, circulated with sea water in the marine version, and a separate raw water system in the land installation.

Pressure charging is by a single-stage axial-flow exhaust gas turbine, having a water-cooled casing, and a centrifugal air compressor: the following are the general pressures and temperatures of pressure charger and intercooler. For an engine at a brake mean effective pressure of 160 lb per square inch and 500 r.p.m., gas temperatures are 810 deg. Fah. indicated at the exhaust valves, 895 deg. Fah. into and 720 deg. Fah. out of the turbine, while 308 lb per minute of exhaust gas pass through the turbine. Temperature of air into compressor is 66 deg. Fah. and passing into the intercooler the air has a temperature of 183 deg. Fah. and a pressure of 17·8in Hg., the corresponding figures out of the intercooler being



Sectional views of " AT " diesel engine

93 deg. Fah. and 17·3in Hg. Starting is by compressed air, which is admitted to each cylinder in the correct sequence through a distributor driven from the camshaft. With regard to the marine engine, mention has been made already of the self-contained drive assembly at the forward end of the engine, while the main drive is through a "Metalastik" flexible coupling, having a variable stiffness ratio, and an oil-operated, reverse-reduction, self-contained gearbox.

Although the engines are uni-directional reversible units can be built using standard parts except for the camshaft. Handed engines for marine propulsion can be supplied using standard basic components since the seating of the cylinder block in the crankcase is symmetrical.

Reconstruction of a London Underground Station

LAST Sunday London Transport's new underground station at Notting Hill Gate was brought into use. Its main purpose is to allow passengers to change directly between the two lines which cross here, and to do away with two surface stations and hence allow road-widening to proceed on the surface.

The old layout at Notting Hill Gate consisted of, first, the Circle Line, 27ft below street level, served by a station on one side of the road, all of which was built in 1868. And second, the Central Line built in 1900, with two deep-level tunnels, the lower platform being 100ft below street level, served by lifts from a station on the other side of the road. Thus the two lines were independent of each other, and passengers changing from one to the other had to ascend to the surface and cross the road. Notting Hill Gate was here only 30ft wide, and carried 32,000 vehicles a day. The road is to be widened to 60ft and extensive demolition and rebuilding is going on all round the area as part of the L.C.C.'s road widening scheme.

As far as the Underground system is concerned, the new works are : a ticket hall built under the roadway (extending across to both sides of the new road) and above the Circle line, steps from this hall down to the Circle line, and escalators descending in three flights to the Central line. The first flight leads to a landing 43ft below the surface, and from here a 200ft pedestrian tunnel, followed by steps up to the platform level, leads to the Circle line platforms to allow "interchange." The second flight descends to the level of the upper (West bound) Central line platform, and the third will carry on to the lower one.

In the first stage of work, now completed, temporary entrances were provided for the Circle line, and the old Central line station and its lifts were kept in use. Construction of the new booking hall was then possible, and also of all the tunnelling works except the lowest flight of escalators. The tunnels were built from a shaft in Notting Hill Gate, which connected with a constructional access tunnel running beside the "interchange" landing. It was not possible to build the lowest flight of escalators at this stage, because they intersect the line of the lift shaft. The escalator tunnel has already been constructed towards the lift shaft, and will now be completed, using the lift shaft for constructional purposes. The closing of the old Central line station will also allow completion of the ventilation system, and of two more entrances to the booking hall, and a road subway.

Tunnelling

The tunnelling works have been carried out by the methods normally associated with tunnelling in the London clay. But, as would be expected, the work has not been as straightforward as entirely new construction would have been, and much care has been necessary. To give one example, one new tunnel was built only 4ft away from existing work.

With the exception of part of the top escalator tunnel, all the tunnels are driven in the London blue clay which lies about 25ft below the surface at this point. Above the clay is a sandy gravel in which the water level is about 5ft above the clay. This stratum of gravel was chemically consolidated by the "Joosten" process in the vicinity of the top escalator. In all, about 17,500 cubic yards will have been excavated by the time the work is completed in mid-1960, mostly blue clay which has been used to fill disused ballast pits.

All tunnels were driven in "free air" by hand with the use of pneumatic spades. Generally, tunnelling was carried out in two shifts, five days a week. Average progress per week was five rings (7ft 6in) in 29ft 6in diameter tunnels, five rings (6ft) in 26ft tunnels (both sizes for landings and machinery spaces), and six rings (9ft) in 22ft 9in tunnels (for escalators). The "interchange" tunnel is 15ft in diameter and the ventilation tunnels are 6ft in diameter: all the tunnels are lined with cast iron segments.

Underpinning the Circle Line

The most difficult engineering problem of the reconstruction was that of underpinning the walls of the Circle Line station to permit the construction of the "interchange" subway which passes beneath them and the Circle line tracks. The two brick walls are 30ft high and one of them supports five girders carrying a street over the railway. About 50ft of wall had to be underpinned. The tracks were supported on temporary steel beams to allow the subway to be built without interfering with rail traffic.

Top flight of escalator at Notting Hill Gate station. The ceiling is of plastic sheets with aluminium cover strips ; the escalators are panelled with aluminium

Another problem was the construction of the ticket hall over the Circle Line tracks which are 27ft below the street level in Notting Hill Gate, thus leaving only a restricted depth for the new construction. It was therefore necessary to demolish the upper part of the brick arch over the tracks. So that rail traffic should not be interrupted, a shield on steel ribs was erected inside the arch. This shield required careful design because of the small space available in the tunnel.

A main 5ft brick sewer which passed through the site of the middle escalator tunnel was diverted before the war, but under the original part of the roadway of Notting Hill Gate were six water mains of 30–36in diameter and three gas mains, two of 14in and one of 24in diameter, as well as a number of smaller pipes and G.P.O. and electricity cables. These services had to be diverted and re-aligned to allow the new subway to pass beneath them and the roof of the subway had to be designed to keep the pipes as low as possible.

Booking Hall and Escalators

At its greatest dimensions, the booking hall, which is irregularly shaped, is 145ft long and 55ft wide, but its average width is about 40ft. Its floor is 12ft below street level. The hall, under part of which is the top escalator machine room, has mass concrete walls 4ft thick and a similar floor 3ft thick, the roof and floor acting as struts to the walls. The portion of the roof under the road is of steel beam construction with concrete filling between and is designed to carry the heaviest British Standard road loading. That part of the roof which will lie under the future buildings is of steel troughing covered in concrete and is designed to carry a uniform floor loading of 100 lb per square foot. The main beams in this area, which are heavy, riveted, built-up girders, are designed to carry the weight of the future buildings above.

The two escalators of the top flight, which has a rise of 31ft, are operated by 40/48 h.p. electric motors supplied by Laurence Scott and Electromotors, Ltd., and run at a fixed speed of 120ft per minute. In the middle flight of escalators, which has a vertical rise of 37ft 7½in, the "down" escalator is operated by a similar fixed-speed motor. The "up" escalator, however, is operated by a Lancashire Dynamo motor of 40/20 h.p., which has a "speed-ray" control and so runs at an idling speed of 60ft per minute. As soon as a passenger steps on, it automatically accelerates to 120ft per minute and remains at this speed until it is again clear of passengers. Both the machines in the lowest flight will be fitted with "speed-ray" control. These machines will have a vertical rise of 16ft 9in and will be driven by 20/10 h.p. Lancashire Dynamo motors.

Use will now be made of the two shafts of the the old Central Line station for ventilation, which will be carried out by a pressure system operated by a fan in the disused stair shaft and a draught relief fairway in the lift shaft. The pressure system entails the construction of two tunnels connecting the lift shaft to the eastbound and westbound Central Line tunnels. These tunnels will be 240ft and 170ft in length respectively.

The consulting engineers for the work at Notting Hill Gate station are Messrs. Mott, Hay and Anderson, and the civil engineering contractor is Balfour Beatty and Co., Ltd. Overall design has been in the hands of the London Transport's chief civil and mechanical engineers and architect ; the finishing contract was carried out by L. and W. Whitehead, Ltd., and the escalator equipment by the Otis Elevator Company.

The scheme is stated to be London Transport's largest post-war station reconstruction, its total cost being £1,000,000. The public subway and two entrances on the north side of the new station will come into use at the end of this year, and the lowest flight of escalators in the late summer of 1960.

"Smoke is Your Enemy."—A leaflet entitled "Smoke is Your Enemy" has been prepared by the Ministry of Housing and Local Government, to answer the questions of householders in projected smoke control areas. It will tell them about the menace of smoke and the part they can play in controlling it. Local authorities in England and Wales who are proposing to make smoke control areas can obtain copies, free of charge, by writing to The Secretary, Room 25, Ground Floor, Ministry of Housing and Local Government, Whitehall, London, S.W.1. The leaflet describes very simply the harm caused by smoke in creating ill health, dirt and waste, and explains how domestic smoke, which causes half the trouble, can be brought under control in densely populated areas. It also explains the procedure for creating a smoke control area, and gives information about the type of fuel which may be used and the grants which are paid towards the cost of adapting fireplaces to burn smokelessly.

Germanium Rectifier Factory

AFTER more than fifty years of experience in the manufacture of high-power mercury-arc rectifier equipment, the Hackbridge and Hewittic Electric Company, Ltd., Walton-on-Thames, Surrey, has now widened its activities to include the supply of rectifiers embodying semi-conductor elements for low-voltage and medium-voltage applications. A new department for the manufacture, assembly, and testing of germanium diodes (air cooled and water cooled) for use in Hewittic rectifiers is in full production. Rectifier equipments using silicon diodes are also being made.

Zone Refining of Germanium

Correct operation of the diode depends on the presence of critically small amounts of impurities in the germanium. Before these elements can be added it is necessary to start with extremely pure germanium. The manufacturing process at the Hewittic works therefore begins with the purification of germanium. The process known as zone refining is used. An ingot of germanium and its containing crucible are placed under a hydrogen atmosphere in a long quartz tube. This tube is surrounded at intervals by three r.f. work coils (Fig. 1), which are arranged to travel together slowly from one end of the ingot to the other, so causing three molten zones about 1in wide to move along the bar in one operation. Any impurities present tend to remain in the liquid metal rather than move across the liquid/solid interface at the trailing end of the zone, and this preference results in their being swept along with the molten zone to the end of the bar.

The presence of impurities is detected by resistivity measurements made along the axis of the bar, whereupon they can be removed by cutting off the end at a suitable point. These measurements are made at regularly spaced intervals on a line ground along the back of the ingot. The germanium is brought into contact with four independently sprung and accurately spaced probes situated in the instrument head. The outer probes pass a controlled current of 1mA, and the resulting volt drop on the inner probes is measured by a sensitive reflectng galvanometer directly calibrated in ohm centimetres.

Production of Single-Crystal Metal

To produce an ingot of metal which is wholly single crystalline it is necessary to control solidification atom by atom. This result is achieved in a special machine in which the germanium is first melted in a cup-shaped quartz crucible, by means of an r.f. work coil supplied at 400 kc/s. A long, thin piece of specially prepared single-crystal germanium (the seed) is then lowered into the surface of the molten metal. Carefully controlled conditions permit the temperature to be high enough to melt the tip of the seed and low enough for a meniscus of liquid germanium to be held up from the molten metal by surface tension forces. The temperature loss through the chuck of the machine securing the seed causes the solid/liquid interface to move slowly down from the seed into the general mass, and when a sufficient diameter of solidification has formed around the tip of the seed, the seed is slowly and continuously raised. This results in a growing column of solid germanium being pulled up from the melt to be left hanging from the seed as a single large crystal.

The operation is carried out in an atmosphere of specially dried high-purity hydrogen, and results in the formation of very clean and bright crystals. Seed rotation and pulling is effected by constant-voltage motors and the seed spindle and main plate are water cooled. Initial seed dipping is effected manually. The introduction of antimony to produce an *N*-type crystal is done during crystal growing by adding to the crucible a carefully calculated and weighed amount of this metal.

The completed crystal is shaped into a square-sectioned stick and cut into 0·03in wafers by means of a small precision diamond saw of the kind used for cutting diamonds. Both surfaces are then lapped to bring the thickness to 0·02in. Every wafer used is centred on the crystal centre so that its isorhos are concentric. This gives the desired result of a symmetrical current density pattern.

Finally, the discs are cleaned and given the necessary surface finish by etching in acids, washing in running de-ionised water, and drying by infra-red heaters.

Rectifying Junction

Next the rectifying junction is made. On one side of a disc of *N*-type single-crystal germanium a slightly smaller disc of indium is placed and the whole is brought up to a temperature greater than the melting point of indium (155 deg. Cent.), but less than the melting point of germanium (980 deg. Cent.). The germanium and indium wafers are loaded and jigged in graphite blocks in batches and alloyed inside quartz tubes, again under an atmosphere of hydrogen.

The electric furnaces surrounding the tubes (Fig. 2) are arranged so that they can be temperature stabilised before being moved along the tubes to the positions where alloying is to take place. This results in junctions of very regular characteristics, and simplifies the controls required.

The liquid indium quickly dissolves germanium up to saturation point, and, upon cooling, the dissolved germanium precipitates out of solution and recrystallises back on to the base germanium. This recrystallised layer of germanium now contains a larger number of indium atoms than it originally did of antimony atoms, and has now been converted to *P*-type so that it forms a rectifying junction with the *N*-type base germanium.

Assembly and Testing

To protect the rectifier junction against contamination by industrial atmospheres, it is hermetically sealed in a glazed ceramic tube which also serves as an insulator between the anode and cathode terminals. The tube is attached to the copper heat sink after the latter has been treated by abrasive vapour blasting for cleaning and finishing.

Encapsulating of the junction in the heat sink is carried out on plastics-topped benches in an air-conditioned room in which a high standard of cleanliness is maintained. Before the final seal is made, the diode is cleaned with specially filtered compressed air, and, finally, vacuum dried.

If it is air cooled, the diode is made as an integral whole, with the junction soldered directly on to the heat sink-cooling assembly ; there are no separate cooling fins or attachments. Thus a low thermal resistance is assured and hot spots are avoided.

Routine tests of reverse and forward characteristics are made with the object of allowing each diode to be graded. This process is followed by a load test in a single-phase, half-wave, resistance load circuit, during which each diode is tested according to its grading. In addition, by means of a special circuit, its on-load reverse current is observed and recorded. Each diode receives a serial number and its characteristics are registered for future reference.

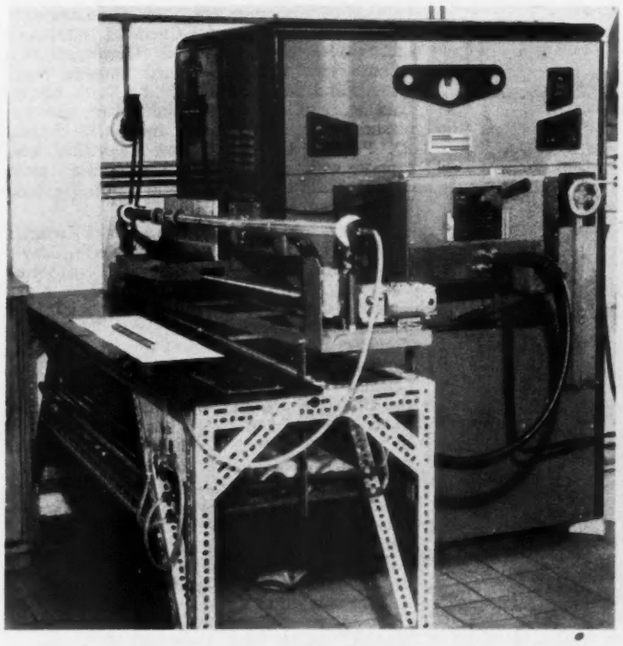


Fig. 1—Zone refining of germanium ingots. This picture shows the motor-driven trolley carrying the three r.f. coils which encircle the quartz tube containing the germanium ingot

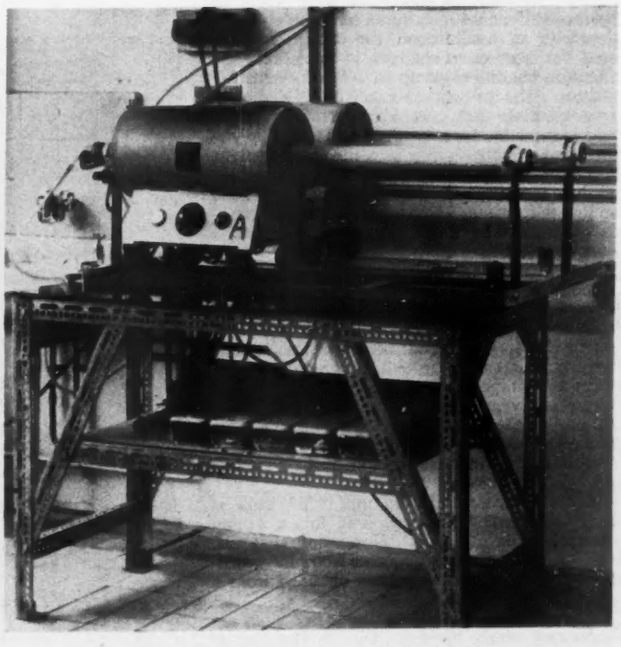
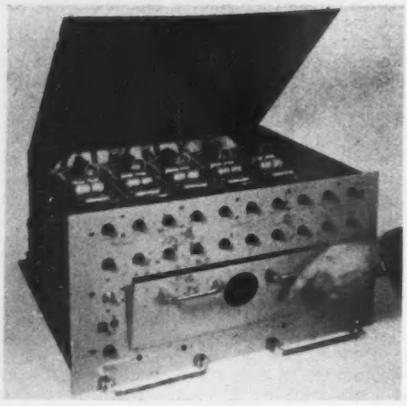


Fig. 2—Twin furnace alloying bench. Germanium and indium wafers are loaded and jigged in graphite blocks placed in quartz tubes for alloying by heat treatment in an atmosphere of hydrogen

Electronic Test Apparatus for Industry

EQUIPMENT recently developed for industrial use by the commercial electronic department of Sir W. G. Armstrong Whitworth Aircraft, Ltd., Baginton Aerodrome, near Coventry, is aimed at assisting manufacturers to improve and cheapen production by detecting design weaknesses in the prototype stage. One example is the "Comel 9" electronic sampling switch, capable of dealing with over 500,000 measurements of strain, temperature, vibration, pressure and position in a minute. Readings may be taken on the spot or transmitted by landline or radio link to a central recording station. This is a low-noise, low-resistance switch which will operate at 12,000 r.p.m. An alternative application of the switch would be its use for providing production flow information in factories at a central point.

A further development is the "Comel 5" recording camera with four-speed gearbox. The camera records on 70mm wide recording film or paper (unperforated) and has a maximum



Display unit for use with recording camera

capacity of 800ft of BK1 recording paper or 500ft of R55 or R60 recording film. In conjunction with an oscilloscope, the camera may be used for recording changes in pressures and vibration conditions at up to 100,000 events per minute. The camera operates on 24V d.c. at approximately 20A. A silicon rectifier power unit is available for use when a mains supply is preferred. Focusing may be controlled remotely, and as the camera is a fairly bulky unit, weighing 80 lb, a focusing unit is built into the lens head so that movement of the camera itself is unnecessary when making final adjustments.

A typical display unit for use with the camera is the "Comel 6," in which the traces of five cathode-ray tube displays can be superimposed by an optical system on a common plane for continuous photography. In these circumstances no time base is required, but time base circuits are incorporated in the unit to provide a waveform to minimise the risk of ion burn of the phosphors when the tubes are used for setting up purposes. Switching arrangements are interlocked so that once the display is set up to "record," the time base is automatically switched off.

On the standard display unit "Y" shift is only provided within the unit for a timing channel. For the actual information channels, this facility is normally available from the recording amplifier; e.h.t. supply is obtained from a separate power unit.

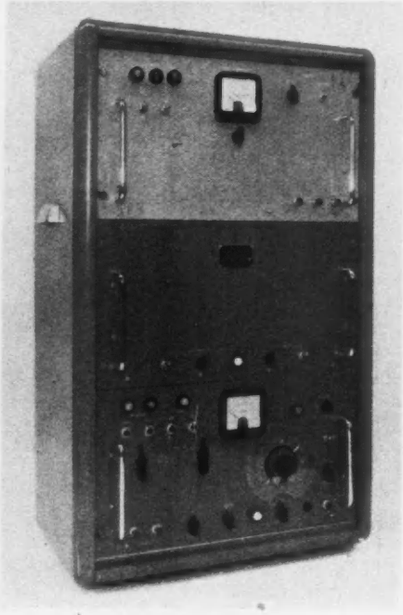
Heater supplies for the cathode-ray tubes are contained within the unit, and on the rear of the unit the "X" and "Y" plate connections are brought out to separate two-pin plugs and sockets. Camera supplies are brought out on the front panel of the unit via an eight-way socket and means are provided for local or remote switching for the camera. Provision is made for adjustment of the optical mirror system to suit any special recording lens system.

A sweep frequency oscillator, the "Comel 8," forming a unit with a vibration controller, as illustrated, enables components to be tested for mechanical resonances in a laboratory by subjecting them to vibrations over a range of frequencies from 10 c/s to 32 c/s. The unit is designed to drive vibrator amplifiers. Accurate control of peak acceleration up to ± 40 *g* is provided. The automatic frequency sweep facility has seven sweep speeds for each frequency range. The sweep can be arranged to reverse or stop at any desired point, and its limits of travel are adjustable anywhere in the range being used. Manual operation of push-buttons can override automatic control of sweep at any time. A square wave output is provided to drive a "Stroboflood" at oscillator frequency or at oscillator frequency plus a small increment of 0·5 c/s, 1 c/s or 2 c/s.

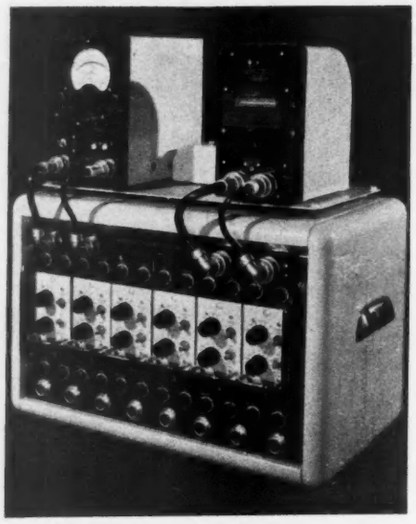
The vibration control section of the apparatus is designed to control the peak acceleration of a vibrator table by automatic adjustment of the vibrator amplifier input during mechanical or electrical resonances. Specifications other than "constant G" can be followed by the insertion of an appropriate function amplifier between the pick-off and comparator in the control loop. While capable of controlling in the range 10 c/s to 32 kc/s, the upper frequency limit is determined by the vibrator equipment. The unit will control up to ± 40 *g* or as determined at low frequencies by the excursion of the table.

For circumstances in which laboratory tests do not meet requirements, a transistor galvanometer amplifier has been developed. This forms one unit of a recording system with wide application in strain gauge, pressure measurement and the general instrumentation field. The amplifier is a modular unit and has been designed to drive viscous damped galvanometers which normally have a resistance of 50 ohms and a working range of d.c. to 2 kc/s in frequency.

The amplifier has a switched attenuator and its input will accept single-ended or push-pull



Sweep frequency oscillator and vibration controller for driving vibration amplifiers



Recorder control unit incorporating transistor galvanometer amplifiers

signals from ± 1mV to ± 500V and will feed a maximum of ± 50mA to the galvanometer. The circuit consists of push-pull stages, each consisting of two grounded collector transistors feeding an emitter-coupled differential amplifier. Two basically similar stages are directly coupled to form a high-gain voltage preamplifier. The push-pull output amplifier is basically similar but is built around two power transistors. A complete recorder control unit incorporating six of these amplifiers is illustrated.

Convention on Plastics Technology

IN conjunction with the International Plastics Exhibition organised by *British Plastics* for June 17 to 27 next, at Olympia, there will be held an International Plastics Convention with the theme "Developing Fields." Sixteen papers will be presented, as detailed below.

Monday, June 22.—10.30 a.m., Polyolefins: "Mechanical and physical properties of polypropylene," by J. M. Goppel, Shell Laboratories, Amsterdam, Holland; "The moulding characteristics of polypropylene," by G. Campbell, Plastics Division, Imperial Chemical Industries, Ltd. 2.30 p.m., Material Developments: "Some new amine hardened epoxide resin systems and their properties," by R. N. Lewis, Bakelite, Ltd.; "Cross-linking of thermoplastics after fabrication," by R. R. Smith, BX Plastics, Ltd.; "Some theoretical and experimental aspects of block and graft copolymers," by J. Benton and C. M. Thomas, British Geon, Ltd.

Tuesday, June 23.—10.30 a.m., Design Trends: "In the United Kingdom," by Robin Day; "In Scandinavia," by Count Sigvard Bernadotte; "In Italy," by Ernesto Rogers. 2.30 p.m., Recent developments in glass reinforced plastics: "In Benelux countries," by Roelf Tunteler, Plastics Research Institute T.N.O., Holland; "In Germany," by H. Kraft, Chemische Werke Huls A.G., Germany; "In the United Kingdom," by Brian Parkyn, Scott Baker and Co., Ltd.; "In the United States," by staff of Owens-Corning Fiberglas Corporation, U.S.A.

Wednesday, June 24.—10.30 a.m., Expanded Plastics: "Recent developments in foamed plastics in the U.S.A.," by Betty Lou Raskin, The Johns Hopkins University, U.S.A.; "Expanded polystyrene: Influence of bulk density upon physical properties," by W. B. Brown, Monsanto Chemicals, Ltd. 2.30 p.m., Extrusion: "Extrusion studies on thermoplastics," by D. A. Lannon and G. C. Karas, British Resin Products, Ltd.; "The extrusion of acrylics," by L. Griffiths, Plastics Division, Imperial Chemical Industries, Ltd.

Japan's First Nuclear Power Station

AS we recorded in last week's issue, the Japan Atomic Power Company has announced that it has opened exclusive negotiations with The General Electric Company, Ltd., of England, for the supply of a 150MW nuclear power station at Tokai Mura, 65 miles north-east of Tokyo. The design submitted by the G.E.C. in collaboration with Simon-Carves, Ltd., has been approved by the Japan Atomic Power Company and will form

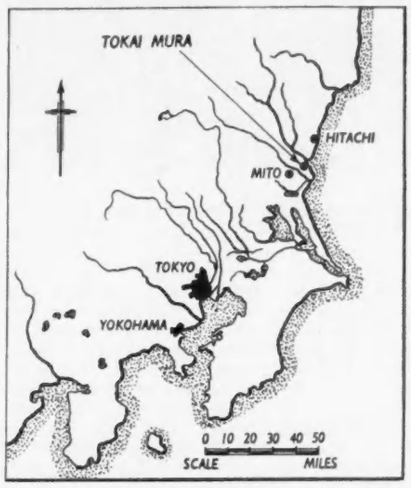


Fig. 1—Proposed location of Japan's first nuclear power station

the basis for the negotiations. It is anticipated that, if these negotiations reach a satisfactory conclusion, a letter of intent will be placed with the G.E.C. later this month, and that details of the contract will be finalised later this year.

In that event, the G.E.C., as the main contractor, would be responsible for the design of the whole project. Certain items of plant, however, would be manufactured by Japanese firms working to the designs of the G.E.C.-Simon-Carves Atomic Energy Group. It may be recalled, in this connection, that the G.E.C. has recently concluded, subject to Japanese Government approval, a long-term licensing agreement with a consortium of fourteen Japanese companies known as the First Atomic Power Industrial Group (F.A.P.I.G.). Besides undertaking some of the manufacturing work for the Tokai Mura power station, F.A.P.I.G. would undertake the site construction work acting under the direct supervision of the G.E.C. and Simon-Carves engineers.

The approximate location of the proposed power station is shown on the sketch map, Fig. 1. The station, which will be designed for a net electrical output of 150MW, will derive its power from a single gas-cooled, graphite-moderated reactor basically similar to the two reactors now being built by the G.E.C.-Simon-Carves Atomic Energy Group for the Hunterston power station, Scotland. As may be deduced from Fig. 3, which shows the proposed layout of the station, the hot gas from the reactor will supply heat to four steam-raising units.

The main differences between the G.E.C. designs for Hunterston and Tokai Mura concern modifications, particularly to the structural and control arrangements, to withstand earthquake conditions.

For example, to lower the centre of gravity of the reactor, charging will be effected from the top. It is proposed that the control rods should be in groups with separate instrumentation and that, in addition to the usual emergency arrangements, shut-down should be initiated by temperature or pressure or seismic trips, or manually, all operable with the reactor tilted at 45 deg. to its normal attitude. In the proposed control system allowance is to be made for the possibility that control rod channels of normal design might be distorted or interrupted by movement of the graphite moderator blocks under earthquake conditions.

Some of the unusual structural provisions can be seen in the simplified sectional drawing of Fig. 2. One form of earthquake restraint is provided by surrounding the reactor core by a cylindrical structure of steelwork, the top of which will be keyed into the top cap, to tie the core to the pressure vessel. In addition, "earthquake restraints" will be provided between the biological shield and a cylindrical lip welded to the top of the pressure vessel. Hollow fuel elements are envisaged in the present proposals.

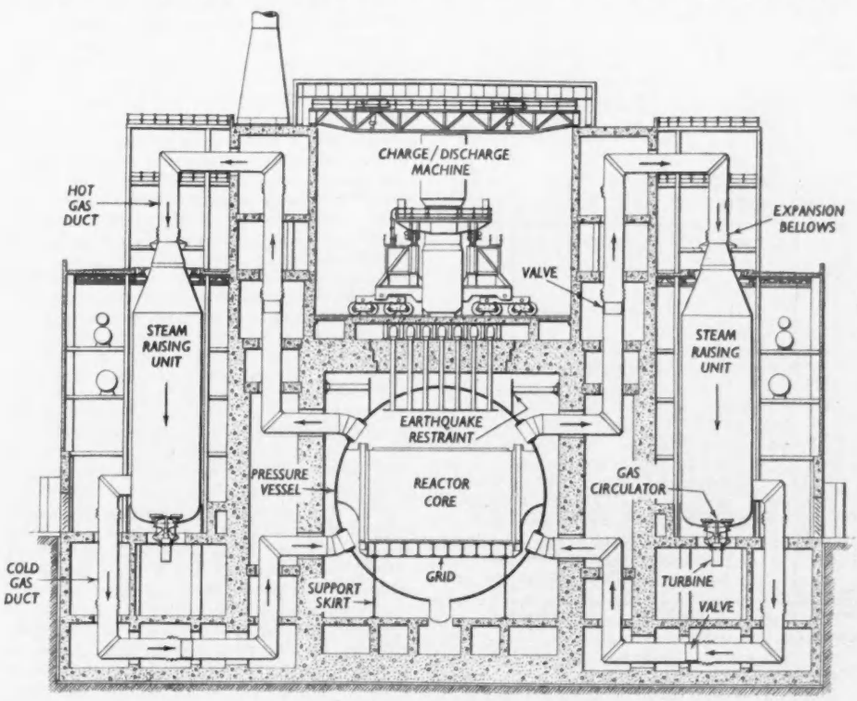
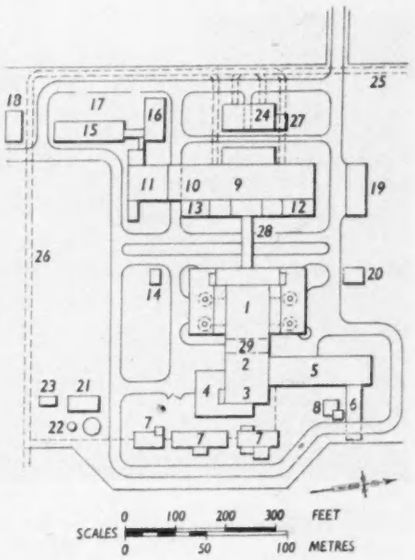


Fig. 2—Simplified sectional drawing of G.E.C. 150MW nuclear power reactor designed for Tokai Mura power station



1—Reactor.
2—Fuel handling building, graphite and uranium store.
3—Charge machine maintenance building.
4—Decontamination, laundry, change room and active medical centre.
5—Cartridge cooling pond.
6—Cartridge cooling pond discharge bay.
7—Effluent treatment plant, settling tanks and delay tanks.
8—Solid waste bunker.
9—Turbine hall.
10—Loading bay.
11—Workshop.
12—Water treatment plant.
13—CO_2 generator.
14—Diesel tank farm.
15—Administration and welfare.
16—Canteen.
17—Car park.
18—Police lodge.
19—Fire station and vehicle hangar.
20—Boiler-house.
21—Sewage treatment plant.
22—Sludge drying beds.
23—Storm water pump-house.
24—Pump-house.
25—Cooling water intake culvert.
26—Cooling water outfall culvert.
27—Chlorination plant.
28—Pipe bridge.
29—Fuel handling bridge.

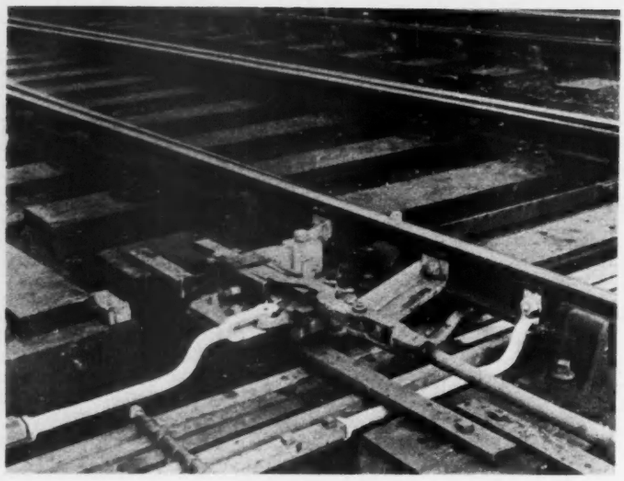
Fig. 3—Outline of proposed site layout of Tokai Mura nuclear power station

The pressure vessel itself is to be a single spherical shell, whereas the pressure vessels of the Hunterston reactors are of double-shell construction (see THE ENGINEER, December 21, 1956, page 891).

The Tokai Mura station is expected to take about four years to build and to be in operation by mid-1963. Its total cost is likely to be in the region of £30,000,000, and the value of the contract to the British consortium will depend upon the amount of sub-contracting work undertaken by the Japanese group as a result of the negotiations now in progress.

HEAVY OIL BURNING.—A paper entitled "Heavy Oil Burning" was presented by J. S. Clarke, Ph.D., and G. J. Hudson, M.A., on Tuesday, January 27, before the Institute of Marine Engineers. The expanding use of oil firing for boilers and the increase in the applications of the industrial gas turbine has underlined the problems of heavy oil burning, and the paper presents a study of the more important factors arising in heavy oil combustion problems. The physical and chemical properties of fuels are considered in relation to the requirements of fuel injection and the different methods of atomisation. Each method is examined and the effect of the common parameters such as velocity, density, viscosity, surface tension, &c., are described. Problems of fuel droplet evaporation and burning times and of carbon deposition are considered, together with the aerodynamic requirements of flame stabilisation. Primary combustion zone flow patterns are discussed and the relation between spray and airflow pattern illustrated. A table lists heat release rates in typical combustion processes, and the paper defines combustors, with enclosed flame, and registers, with open flame, and treats their special problems of design and performance together with practical examples of air registers designed for marine and industrial boilers. Flame stabilising is described and the paper concludes with examples of various fuel systems and an appendix concerned with instrumentation for gas analysis.

Double-bolted facing points, showing the two lock castings and lock stretchers passing under stock rails

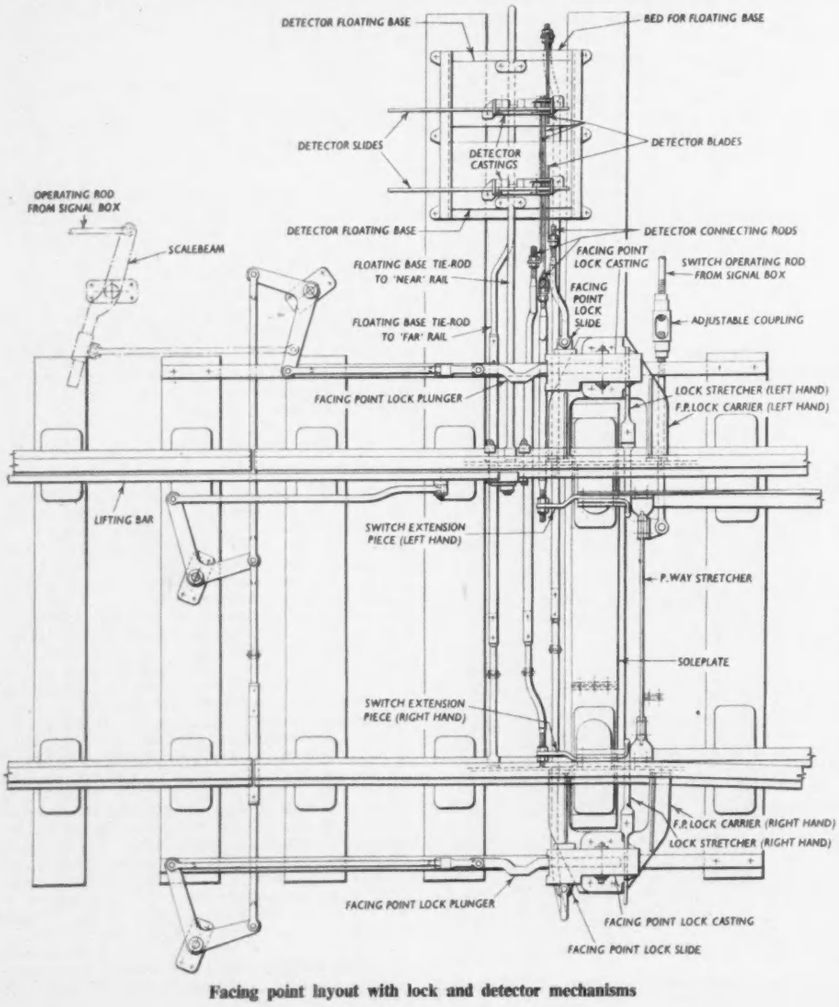


Lock casting with cover removed to show plunger and lock slide to signal detector

Double-Bolted Facing Points

THE generally accepted method of locking facing points on the railways of this country has consisted basically of a lock plunger engaging with a lock stretcher rod rigidly connecting the two switch blades. A theoretical objection to this principle, namely, that the switches are locked relative to a plunger box in the 4ft way and only indirectly in relation to the stock rails, was mentioned in a paper presented recently to the Institution of Railway Signal Engineers,* although in practice a strict maintenance procedure overcomes this difficulty. It is also possible, however, for a lock in the 4ft to be struck by objects hanging from passing trains, with the risk of a switch being forced open while a train is running through it. Such a mishap was the cause of the Blea Moor derailment on the Leeds–Carlisle section of the London Midland Region, British Railways, in 1952, when the damage was done by a brake coupling rod hanging loose under the tender of one of the locomotives hauling the train.

* The Protection of Facing Points. O.S. Nock (Westinghouse Brake and Signal Company, Ltd.).



Facing point layout with lock and detector mechanisms

Various developments are taking place at the moment in forms of lock which overcome these objections by being located in the 6ft, and by locking both switch rails positively with respect to the stock rails. One such system, adapted by the London Transport Executive from the French National Railways chair lock, was illustrated in our October 24, 1958, issue. Similar work has been going on in other Regions of British Railways, and by the courtesy of Mr. E. G. Brentnall, signal engineer, London Midland Region, we are able to illustrate a double-bolted facing point layout which is under trial at certain locations in that Region. This development has been guided by the principle of using British Standard signalling equipment as far as possible.

It will be seen from the illustrations and drawing that two standard lock castings are used and are mounted on lock carriers bolted to the rails so that their position relative to the respective rails is positively determined. A lock stretcher of a new design is attached to each switch rail, and, passing under the stock rail, slides to and fro in the lock casting with the movement of the switch. Two locking faces on the stretcher are presented alternatively to the plunger according to the position of the switch.

The plungers are operated together through rodding and right-angle cranks by a lever in the signalbox separate from that which controls the points. Referring to the diagram, movement of the plungers to the right bolts the points by each plunger entering a notch in the stretcher. The plunger on the closed side of the switch thus bolts the switch rail against the stock rail. On the open side of the switch the corresponding plunger engages with a notch at the end of the stretcher so as to preserve a requisite minimum opening of 3½in between the switch rail and the stock rail.

It can be seen from the drawing that the signal detector floating base is located positively relative to the switch by means of tie rods to the near and far rails so that accurate registration is observed between the detector slides and blades. The function of the detector mechanism is to prevent a signal for a route from being cleared until the points have been proved fully thrown and bolted for that route. While the signalbox interlocking holds the signal lever until the points lever has been thrown and the bolt operated, this second precaution on the track provides for the possibility of the points not having moved in correspondence with the lever. One of the photographs reproduced shows how the lock plunger is shaped so as to operate the slide to the detector by a cam action.

SHORTER REPORTS

Technical Colleges and Research

At the annual general meeting, last Friday, of the Association of Technical Institutions, the secretary of the Department of Scientific and Industrial Research, Sir Harry Melville, expressed the hope that the number of post-graduate research students in technical colleges might be increased. Sir Harry said that the D.S.I.R. research studentship was an award which until a few years ago went under the more prosaic title of "D.S.I.R. maintenance allowance." It was an award intended to provide a training in methods of research for young people holding good honours degrees or acceptable alternative qualifications. It was hoped to make nearly 800 new awards of this kind this year and the total number current after next October was likely to be about 1800. In each of the next few years the number of new awards made annually was likely to increase by about 10 per cent.

When these awards were started soon after the first world war, Sir Harry continued, a number of the older technical colleges came to the department for "this form of help." He was surprised to learn that although in 1922 only 156 research studentships were awarded, the number granted for tenure in technical colleges was greater than in 1956. In fact, he explained, in 1922 the technical colleges took up nearly 10 per cent of the D.S.I.R. awards, a figure which dropped to about 1 per cent in the 1930s but which last year rose again to nearly 7 per cent. It would be idle to deny, Sir Harry commented, that the attractions of the universities for the academically brilliant youngster were very strong, and that, consequently, a large proportion of all students suited to post-graduate research was likely always to come from the universities. He urged, however, that attention should be given to ways of encouraging students to take their research qualifications in a wider range of institutions than at present. It remained to be seen, Sir Harry added, whether the newly-created Hives research qualification of "Membership of the College of Technologists" would provide an award as popular as a Ph.D. Sir Harry referred also to efforts being made to encourage young science graduates and engineers to spend at least one year of their post-graduate training abroad. The objects of this, beyond providing post-graduate training, were to mix promising British post-graduate students with those of other countries, to enable them to work in overseas laboratories, and to help them benefit more generally from the interest and stimulus of study abroad. It had also been announced, he said, that the D.S.I.R. would administer in this country a scheme of science studentships and fellowships for N.A.T.O., which would encourage international exchanges. Furthermore, there was on the stocks a Commonwealth Scholarship scheme.

Highland Water Power

The North of Scotland Hydro-Electric Board's annual report for 1958 states that the Board, in its first fifteen years, has completed the development of about a quarter of the estimated usable water power resources of the Highlands. The report states that at the end of the period, the deficiency on revenue account stood at £724,456 after taking into account a loss of £112,238 on operations in 1958.

Conditions in the year 1958 were against a balanced budget, the Board asserts; rainfall was 14 per cent below average, this being the second dry year in four, interest rates on long-term borrowing remained high, and slackening of industrial activity in 1958 reduced the expected increase in sales.

The Board has not relaxed its efforts to bring new industries to the Highlands, the report states, and amongst those which started during the year were the assembly of domestic cookers by The General Electric Company at Inverness and the quarrying and crushing of magnesium limestone for agricultural purposes by William Lind and Son at Ullapool. An experiment in "devolution in manufacture" is being pursued by one large organisation which has practically all its present production in the south. This firm intends to contract out to existing establishments in the Board's area the manufacture of small components. Over thirty firms in the area have already submitted details of their available capacity.

The present state of the programme of hydro-electric development is as follows:

	Capacity, MW	Average annual output, kWh × 10^6
Already in operation ...	813	2293
At constructional stage ...	169	432
In course of promotion ...	448	527
Under survey	224	765

During the year hydro-electric plant with an installed capacity of 84MW was brought into service. There are now thirty-four post-war hydro-electric power stations in operation and fourteen at the constructional stage.

The number of units sold to the Board's consumers during the year was 1349 million, and the maximum demand was 437MW in January. This figure does not include the islands and areas with independent generation for which about 22·5MW should be added. The Board exported 463 million units to the South of Scotland Electricity Board and, in continuance of the interchange arrangements with them, bought 73,100,000 units. The Board's power stations generated 2043 million units of electricity, 1683 million of which were produced by water power. The Highland grid system now totals 1630 circuit miles with another 250 circuit miles being built. Capital expenditure during the year amounted to £15,398,133 and the Board's aggregate capital expenditure to the end of the year was as follows:

	£
Hydro-electric schemes	132,591,000
Steam and diesel power stations ...	5,522,000
Transmission lines	15,135,000
Distribution...	37,545,000
Sundry	1,508,000
	192,301,000

Dividing the first of these figures by the total capacity of 813MW given in the previous table, it can be seen that the Board has spent just over £160 per kilowatt installed, with just over 10 per cent in addition on transmission.

Dry Dock Project on Tyneside

We are informed that the Mercantile Dry Dock Company, Ltd., Jarrow-on-Tyne, has decided to proceed with the construction of a new dry dock, to be known as its No. 4 dock, at an approximate cost of £1,000,000. Work will begin within the next few weeks, it is stated. The new dock will accommodate ships up to 24,000 tons deadweight. It will be 600ft long, with a width at the entrance of 85ft, and the depth of water over the sill on high water ordinary spring tides will be 23ft 6in. It will be built 860ft downstream from the existing No. 1 dock, and will face down river, cutting in to the yard at an angle of about 45 deg. to the river frontage. The existing deep water quay, which was completed early in 1955, will be extended eastwards to form the west entrance roundhead of the new dock, giving a quay length of 650ft clear of dock entrances.

The construction of the new dock will be with steel-sheet-piled walls, with reinforced concrete upper works, comprising altars and service tunnels carried on a relieving platform supported and tied back by raking concrete piles; a mass concrete floor founded on boulder clay, and a reinforced concrete pump house constructed in an independent cofferdam; the gate will be a "box" gate; the usual piped services will be accommodated in tunnels down both sides of the dock, together with electric cables and welding switchboards. A 17½-ton "Monotower" electric travelling crane traversing the full length of the west side of the dock will link up with the similar 10-ton crane on the quay. Other work includes dismantling and rebuilding the blacksmiths' shop and construction of a new access road, two new substations, a new oxygen and acetylene plant house and a new lavatory block.

The firms taking part in the new project are: consulting civil engineers, R. T. James and Partners; consulting electrical engineers, R. W. Gregory and Partners, Newcastle upon Tyne; main contractor, Sir Robert McAlpine and Sons (North Eastern), Ltd.; electrical contractor, Johnson and Phillips, Ltd.; gate, Head Wrightson and Co., Ltd.; pumping equipment, Drysdale and Co., Ltd.; 17 tons 10 cwt crane, Butters Bros. and Co., Ltd. The dock is scheduled for completion early in 1961.

Chapelcross Nuclear Power Station Starts Generating Electricity

The first of four reactors in the nuclear power station at Chapelcross, near Annan, Dumfriesshire, began generating electricity on February 25, four days ahead of schedule. After becoming critical last November this reactor has now completed its testing and commissioning period. For some time it has been producing steam for absorption in a dump condenser but now, with the commissioning of the steam circuits and turbo-generator, electricity is being generated.

The Chapelcross station, which will have a generating capacity of 184MW and will when all four reactors are completed supply about 140MW to the national grid, has been built by the United Kingdom Atomic Energy Authority as a dual purpose station to produce plutonium and electricity. In this respect and in its general design it is similar to the Calder Hall station. The nuclear power station under construction at Hunterston, however, is being built for the South of Scotland Electricity Board, expressly for electricity generation and it will supply 320MW to the grid.

The construction of Chapelcross is under the control of Messrs. Merz and McLellan, acting as agents for the Atomic Energy Authority's industrial group; it is the first occasion on which a private firm has been so employed in this way on a major project of this kind. The official opening of the establishment, by Col. Sir John Crabbe, O.B.E., M.C., T.D., Lord-Lieutenant of Dumfriesshire, will take place on Saturday, May 2, 1959, when the station will be open to the public.

Amongst the contractors who provided equipment or services for the construction of Chapelcross are: Babcock and Wilcox, Ltd., heat exchangers; Findlay and Co., Ltd., steelwork; Jas. Kilpatrick and Son, Ltd., electrical installation; Mitchell Construction Company, Ltd., civil engineering; C. A. Parsons and Co., Ltd., turbo-alternators; Stewarts and Lloyds, Ltd., pipework; Whessoe, Ltd., pressure vessels.

Oil Engine Manufacture

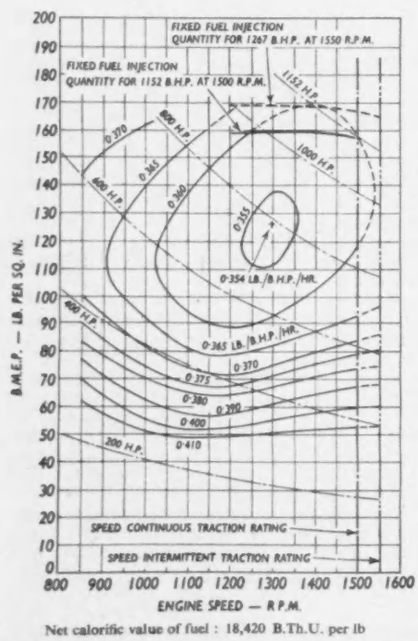
In our account of the British Railways diesel-hydraulic locomotives based on the V.200 class of the Federal German Railways (page 105, July 18, 1958) it was mentioned that the Maybach engines employed might be built under licence by Armstrong Siddeley Motors, Ltd. An engine has now been assembled at the Ansty works and submitted to British Railways 100-hour acceptance test : plans have been prepared to install

Drive end of V-12 Maybach engine

machinery for the production of individual components. We reproduce here the performance curves for this individual engine : it should be observed that these are not the guaranteed curves for production engines, but rather better than average. It will be noticed that, as is normal on an exhaust-turbine supercharged engine, the best operating line tends to be rather steep on a base of speed, i.e. it is not desirable to load the engine heavily at much reduced speeds. We understand that in its present form the output of the engine is limited by the allowable turbine temperature, 500 deg. Cent., being reached at low revolutions per minute : if this limit were raised power would probably be restricted by the heat transfer rates attainable through the aluminium-coated liners without corrosion or erosion of the outer surfaces.

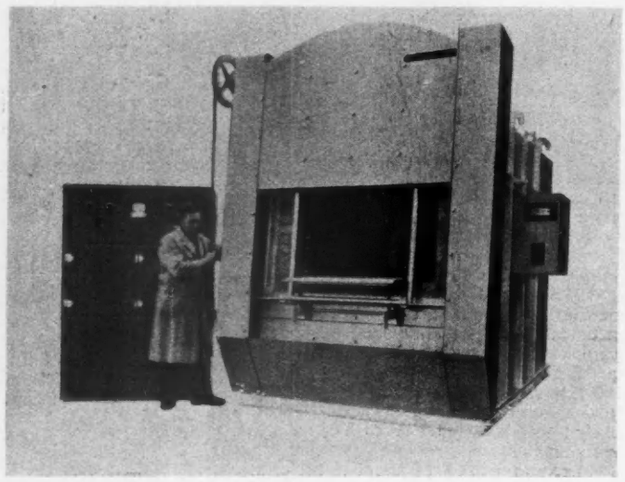
It is worthy of note that when these engines are provided with inter-coolers and the necessary additional water radiator, the permissible brake mean effective pressure improves to 200 lb per square inch and the consumption at this torque is guaranteed at near to 0·36 lb per brake horsepower per hour.

Our description of the " Sir Brian Robertson " stated that the engines were equipped with dynamotors for starting and to supply the electric signalling system commanding the governors. The engines supplied by Maybach to Armstrong Siddeley Motors do not conform to this description : they have no generators, and where starters are fitted they are electric motors driving through duplex sprocket chain and torque-limiting friction clutches to conventional Bendix inertia drives on the exposed ring gears. The engine illustrated does not have this equipment, nor does the governor have the electrical servo-motor which selects " stop " when the " dead man's handle " is released.



Net calorific value of fuel : 18,420 B.Th.U. per lb

Performance of " MD 650 " turbo-charged twelve-cylinder engine



Electric batch furnace for general heat treatment, having a temperature range up to 900/1000 deg. Cent., with a nominal rating of 100kW

Institution of Electrical Engineers

The modern need for learning to speak each others' technical languages was emphasised by the Lord Chancellor, Viscount Kilmuir, when he proposed the toast of " The Institution of Electrical Engineers " at the Institution's annual dinner in London on February 26. Viscount Kilmuir agreed that one must accept the inevitability of technical specialisation, but there was a real danger that specialisation might become exclusive. It was a danger that might be accentuated by the growth in total membership from 20,000 in 1940 to 36,000 in 1950 and 44,000 in 1959.

One aspect of this expansion was touched upon by Mr. S. E. Goodall, the president of the I.E.E., in his response. Mr. Goodall pointed out that although the 30 per cent increase in the numbers of professional electrical engineers called for in the 1956 White Paper was not likely to be reached the situation should improve now that the Dip. Tech. engineers were providing a new stream of recruitment to the profession. However, it was possible to visualise a deficiency in quantity and quality of practical training that was available to these young recruits. The larger firms were doing all that could be expected, but some of the smaller firms that could do little individually might achieve a great deal by joining together in groups to provide practical training, as was being done successfully in Scotland.

The toast of " The Guests " was proposed by Mr. T. E. Goldup, immediate past-president of the I.E.E., and the response was made by Sir Norman Kipping, in the absence, through illness, of Sir Hugh Beaver.

Electric Furnaces

Heavy-duty horizontal electric batch furnaces for general heat-treatment processes are now being made by Barlow-Whitney, Ltd., 2, Dorset Square, London, N.W.1, in two basic models. One model is designed for operating temperatures up to 950 deg. Cent. (maximum 1000 deg. Cent.) and the other for temperatures up to 1100 deg. Cent. (maximum 1150 deg. Cent.). In the first model heavy-gauge 80-20 nickel-chromium spiral heating elements are housed in specially moulded carriers and operate at normal mains voltage. In the higher temperature models strip elements are employed and fed from a step-down transformer at a reduced voltage.

Both types of these furnaces are available in a number of chamber sizes from 18in wide by 9in high to 48in wide by 36in high with optional front to back depths up to 96in. The use of carefully graded insulation in construction and the fitting of fully automatic electronic pyrometric temperature controller provide consistent performance in operation of the furnaces. One of the furnaces is illustrated herewith : the optional features available include door heating, a retractable loading platform, a gas curtain and, on the larger units, zone control and a power operated door.

Flexible Oil Barge Progress

Work on the development of flexible barges and a demonstration of the " Dracone D.1 " was described in The Engineer of September 26 of last year. This prototype has a length of 100ft and a diameter of 5ft and is made of very strong woven nylon cloth coated with synthetic rubbers, the deadweight being about 40 tons. Since September extensive handling and towing trials have been carried out by Dracone Developments, Ltd., 1, Tilney Street, London, W.1, and last month further progress was made with the successful delivery of an oil cargo. With the co-operation of the Esso Petroleum Company, Ltd., the flexible oil barge was loaded with 10,000 gallons of kerosene, at the company's Fawley refinery, and then towed to its oil depot at Newport, Isle of Wight. The distance down Southampton Water, across the Solent, up the River Medina to Newport is approximately 10 miles and the time taken to tow the barge by a small launch of 45 h.p. was under two hours, to give a towing speed of 5 knots.

At Newport the " Dracone " was emptied in sixty-five minutes by means of a compact self-contained pumping unit consisting of a Goodyear size 12 pump driven by a Petter mark PC2 diesel engine and mounted in the towing launch. For returning the empty " Dracone " it has been reeled and a towable reel is being developed; however, on this occasion a new technique was used. Instead of reeling the " Dracone " it was allowed, on being emptied, to flatten and sink to the bottom of the harbour, and then connected to carbon dioxide cylinders and inflated, an inert gas being used to obviate any risk of fire from the generation of static electricity.

Further trials are to take place in home waters and two " Dracones " have been ordered for trials in West Africa, while the first 350-ton barge is now being built.

Radial Arm Saw

A UNIVERSAL radial saw now made by Wadkin, Ltd., Leicester, has a saw head that can be swivelled to any angle to enable the machine to do cross cutting, mitring and compound mitring, as well as straight and bevel ripping. The spindle can be fitted with trenching heads for a wide range of ploughing, grooving, birdsmouthing, &c., and moulding and rebate irons can also be used on this machine.

With a 14in saw, as shown in our illustration,

Universal radial arm saw which can be adapted for cross cutting, mitring, bevel ripping, ploughing and grooving

the machine will cut a maximum width of 14in and a maximum depth of 4½in, or 17in wide by 1in deep. The saw assembly is slidably mounted on an overhead arm which has a vertical adjustment of 14in. The arm can be swivelled up to 45 deg. either way and the saw carriage, which can be locked at any position along the arm, can be rotated through 180 deg. The saw head can also be tilted inside a yoke mounting to any angle between horizontal and vertical. With the spindle set in the vertical position the machine becomes an overhead moulding and recessing machine.

Plunger stops are used to locate the members at all the principal angles on both the arm and saw unit, and locks are fitted on all movements. The motor, which is directly on the saw spindle, is rated at 3 h.p. and controlled by push buttons.

The machine has a universal guard to provide adequate protection at all positions of the head and a riving knife and a kick-back device are built into the guard. The machine is mounted on a fabricated steel base which can be fitted with panels and hinged doors to form a tool cabinet, and its 4ft by 1ft wooden table is mounted on levelling screws. If required an adjustable fence and a cutting off stop bar can be provided on the machine.

Electronic Engineering Association

EXPANSION in all branches of electronics has led to the decision that in future the capital goods and consumer sides could be recognised with advantage to all concerned as two distinct industries, each with its own objectives and policies. The report for 1958 of the Electronic Engineering Association records, therefore, that as from January 1 this year the association has given up its right to nominate representatives to the Radio Industry Council, thereby permitting the three remaining nominating bodies, the British Radio Equipment Manufacturers' Association, the British Radio Valve Manufacturers' Association, and the Radio and Electronic Component Manufacturers' Federation, to devote their attention to the affairs of the domestic broadcast entertainment industry, so enabling the association to take full responsibility for the capital goods interests of the industry.

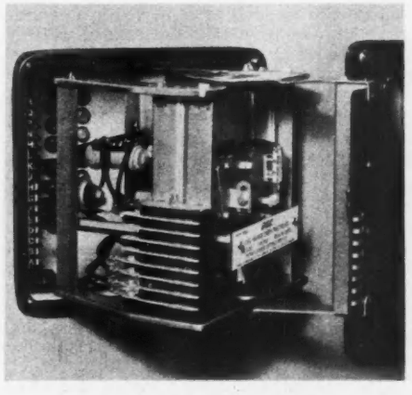
In a review of the past year, the report notes as an outstanding feature the exhibition of electronic computers at Olympia, London, organised jointly by the association and the Office Appliance and Business Equipment Trades Association, at the instigation of the National Research Development Corporation. The exhibition attracted 38,329 visitors in six days, who came from forty-one different countries. Attention is drawn to the growing use of computer techniques in industrial processing. When a complex series of operations is required, the timing of each process can either be predetermined on tape, or it can be made dependent on the various parts of a successive process. This system is proving particularly valuable in the steel industry. Of considerable importance is the use of computers in process planning. Complex operations, such as the loading of knitting machines to produce a given number of garments of certain textiles, can be more effectively planned by a computer than by factory management.

Other sections of the report deal with electronics in transport, nuclear engineering and communications. Progress in meeting the problem of providing radio communication facilities on the frequency ranges available is exemplified in the performance of the experimental tropospheric scatter link between Start Point, Devon, and Galleywood, Essex (just over 200 miles), which in its present form can carry sixty simultaneous telephone channels and offers possibilities of wider band transmission in future. A system of converters has also been developed for enabling one radio transmitter and one receiver to handle two simultaneous channels. The intelligence carried may be high-speed Morse, teleprinter, or time-division multiplex.

Withdrawable Relays

A RANGE of withdrawable relays (known as "Swingtest") has been introduced by The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. The relay assemblies are designed to allow for rapid replacement of a faulty relay and to give improved facilities for secondary injection testing.

In each relay of the range, a series of bridge contacts mounted on a contact carrier completes a circuit between two vertical rows of contacts



"Swingtest" relay, in this case a core balance earth fault relay, fully withdrawn for inspection

fixed to the case and relay unit. Rotation of the bridge contact carrier through 90 deg. isolates the relay, automatically short-circuits any current transformer circuits, opens trip circuits and mechanically unlocks the relay unit so that it can be withdrawn from the case on slides. When fully withdrawn, as illustrated, the relay unit can be swung round on two pivots, thus exposing all sides for inspection; alternatively, should a long examination be necessary, it can be completely removed by lifting it from the pivots.

To injection-test the relay unit in the case, the bridge contact carrier is rotated beyond the "withdraw" position to lock the relay firmly in the case; a split test-plug is then inserted in the space normally occupied by the bridge contact carrier. Insertion of the test-plug completes the current transformer and tripping circuits, and the relays can be tested safely with the associated primary equipment remaining in commission.

"Swingtest" withdrawable relays are available in five case sizes. With the exception of the smallest size, they occupy the same panel space as the conventional flush types and fit into the same cut-out.

High-Pressure Flexible Hose

AN extra-high-pressure flexible hose for the conveyance of gases and liquids has been developed by the Dunlop Rubber Company, Ltd., St. George's Road, Coventry. This hose, which is reinforced by three high tensile steel braids, has 1¼in diameter bore and can be used with a working pressure of 4000 lb per square inch. A nitrile rubber used for the seamless inner lining enables the hose to handle a variety of gases and liquids, including nitrogen, mineral and vegetable oils, petrol, kerosene and coolants, and it has an abrasion—resistant neoprene outer covering. Fluids can be handled at operating temperatures up to 130 deg. Cent. and ambient temperatures from −30 deg. Cent. to +100 deg. Cent.

Metal end fittings are "swaged" on to the rubber hose, forming an indented pressure seal. A steel insert has an integral annular ring with a wedge-shaped seating formed on the underside, which makes contact with the face of the inner lining tube. An outer ferrule or sleeve ensures that during "swaging" the seating will indent the face of the rubber to form a leakproof seal.

New Trains for Metropolitan Line

THE London Transport Executive has placed an order for 248 cars to replace existing electric and steam compartment stock on the Amersham, Chesham and Watford services of the Metropolitan Line. The contract for the car bodies and bogies has been given to Cravens, Ltd., of Sheffield. Orders for the motors and other equipment for the new trains have already been placed (THE ENGINEER, February 20 and 27).

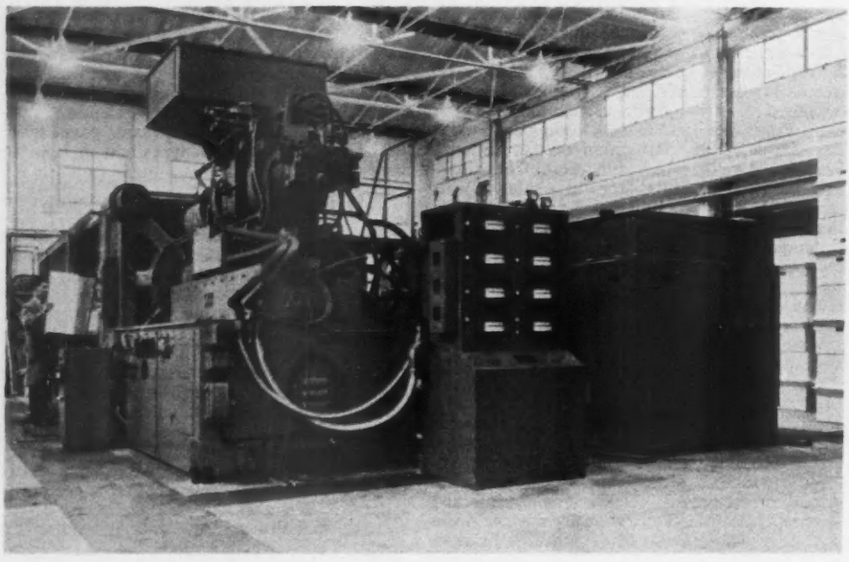
The Metropolitan trains will be of a new saloon design providing 40 per cent more seats than other saloon cars now running on the Underground. All seats will be in facing pairs on each side of a central gangway. Parcels racks will be fitted and the cars will have power-operated sliding doors. Lightweight construction with unpainted aluminium bodies, light alloy underframes and body parts will save over 5 tons of weight per car. All-rubber suspension will be used. It is planned that the new trains will begin coming into service towards the end of 1960 and will all be running when the electrification of the steam-operated section between Rickmansworth, Amersham and Chesham, and the four-tracking of the line from Harrow to beyond Moor Park are finished in 1962.

Astronautics Events

THE fifth United States moon probe was launched from Cape Canaveral on March 3. "Pioneer IV," like "Pioneer III," employed the "Juno II" launching vehicle (see page 66, January 9 last), but the probe weight was increased from 12·95 lb to 13·4 lb. The probe is a glass-fibre cone plated with gold, and finished in light and dark stripes in the usual way to attain the desired temperature for the instruments. The main instrumentation is intended for further investigation of the Van Allen radiation belts, although a much heavier vehicle, it is believed, will be necessary to determine the nature, as distinct from the intensity, of this radiation. The probe is expected to pass within 35,000 miles of the moon: it appears to have been launched on a short-time trajectory a few hours slower than that of "Pioneer III."

Unconfirmed reports reaching West Germany from the U.S.S.R.* state that an object has been recovered from an orbit round the earth. The body made three orbits of approximately 105 minutes' period in early February and landed within the Soviet Union. It weighed about 500 lb: a wood-base ablative shield failed to preserve the instrumentation during re-entry, it is reported.

* Aviation Week, 70, No. 6, page 25.



Injection moulding machine with a locking force of 1150 tons, making a complete inner lining for a refrigerator

Large Injection Moulding Machine

AN injection moulding machine which is believed to be the largest in service in this country is now in operation at the Southend works of Ekco Plastics, Ltd. This machine was designed and built by R. H. Windsor, Ltd., Chessington, Surrey, and the swept volume of its injection stroke is 335 cubic inches, or equivalent to 210 oz of polystyrene, when working at maximum capacity. It is fitted with one of the maker's "Autoplas" pre-plasticising units and has a plasticising capacity of 420 lb of polystyrene an hour.

The 5in diameter injection plunger of the machine has a stroke of 17in and, with the total load of 245,440 lb which can be exerted on the plunger, a pressure of 12,500 lb per square inch is exerted on the plasticised material in the chamber. With an injection plunger speed of 315in per minute a complete injection stroke is effected in three and a quarter seconds. Very large moulds, up to a combined thickness of 44in, can be taken by the 70in by 62in mould plates of the machine, which has a mould opening of 42in with a maximum daylight of 86in. To provide for the very large capacity a maximum locking force of 1150 tons is available.

All functions of the machine are hydraulically operated and the required sequence is preset by controls and timers grouped on a panel at the head end. Once the sequence has been set the injection cycle is started and completed by the machine operator moving a single lever.

In the photograph we reproduce of the new machine the pre-plasticiser unit can be seen mounted above the injection plunger assembly. This unit, working in timed sequence with the plunger to deliver a shot of plasticised material into the chamber prior to each stroke, reduces the dwell periods between injection strokes and considerably speeds the working cycle of the machine.

At present the machine is being used for the production of liners for the domestic refrigerators made by Frigidaire. These open, box-shaped liners are made of "B.X." polystyrene and measure 26¾in by 19¾in by 14in. For each liner a shot weighing 104 oz is used and one liner is produced every seventy seconds on the machine. The moulds used for this job weigh some 7 tons and incorporated in the sides are pins which are inserted automatically by hydraulic plungers when the mould halves are closed to provide cores for a number of holes in the sides of the liners. In the photograph the operator can be seen removing a liner from the machine.

Coiled Tinplate

THE first coils of tinplate to be produced in this country have recently been made at the Velindre works of The Steel Company of Wales, Ltd. When the No. 2 electrolytic tinning line was installed at Velindre it was equipped with twin recoilers situated immediately following the drive bridle. They have now been brought into use and are ready to supply the demand for coils. At present only a few tinplate users have the necessary facilities to handle coils but it is understood that others are planning to include such equipment in proposed new plants. Adjustments required to change over the line to coil production have been reduced to a straightforward routine, after which the operations proceed at an increased speed. Strip passing through a down and upcut shear is cut and deflected down a conveyor to the recoiler, where a belt wrapper causes it to coil around a collapsing mandrel. The strip is then recoiled at speed until the required size of coil has been built up. Push-button control is sufficient to shear the strip and deflect the leading end into another conveyor leading to the second recoiler without actually stopping the line. The recoilers are equipped with "Askania" edge control which causes each mandrel to be moved hydraulically to follow any direction of one edge of the strip. This control provides coils with uniform sides. Coils which at present weigh up to 7 tons, according to the customer's needs, are wrapped in corrugated bituminous paper before being despatched from the works.

Automatic Correction of Telegraphic Errors

IT is announced by Marconi's Wireless Telegraph Company, Ltd., that production has begun of the new "Autoplex" equipment for the automatic detection and correction of errors in radio telegraphy transmission and that fourteen of these equipments have already been ordered by the General Post Office, while a further fourteen are being manufactured for use by Cable and Wireless, Ltd. By making for higher accuracy in the transmission of radio telegraphy than has hitherto normally been possible, "Autoplex" equipment is stated to offer a means of increasing traffic-handling capacity and also to enable h.f. radio telegraph networks and ionospheric scatter circuits to be connected into the international Telex system.

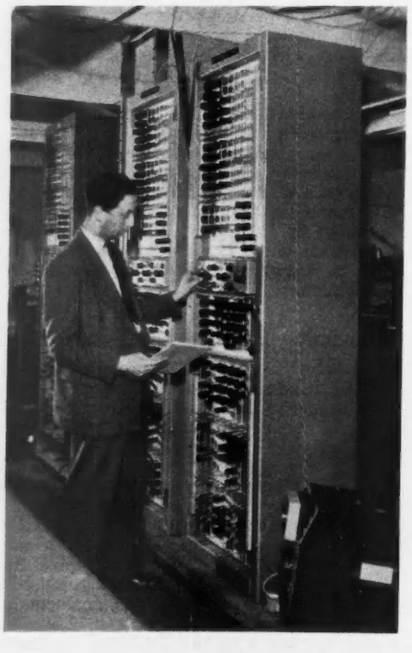
Current pressure on radio telegraphy services is making it desirable to mechanise the handling of traffic. Hitherto, however, there has existed no straightforward automatic method of detecting and obtaining correction of errors in transmission. Largely because of this, most radio telegraph traffic is at present transmitted and received by operators, so that received copy can be inspected at once and retransmission requested where required. Among the disadvantages of this procedure is the fact that it limits the extension of the h.f. telegraph network beyond the radio terminal and prevents direct connection into the Telex network.

With Marconi "Autoplex" (automatic error-correcting multiplex equipment) a fully-electronic means is provided of detecting and immediately correcting errors which arise during automatic transmission, thus permitting the use of data processing machinery and computers at the receiving end. On receipt of a character which has become distorted in transmission, the "Autoplex" equipment at the receiving end initiates a request for repetition which is transmitted to the sending station on another frequency. This signal, when received, interrupts the flow of information and automatically initiates retransmission of the group of characters which contains the queried one. This done, the transmission reverts to normal without human intervention at any stage.

The apparatus, which is based on the work of Dr. van Duren of the Netherlands P.T.T., is designed to be integrated into newly-established circuits or for addition to existing circuits where the equipment and transmission conditions are suitable. It may be connected directly to any h.f. telegraph circuit with a traffic capacity of 100 bauds. Where 200-baud circuits are available, two such terminals can be used on the basis of element interleaving. Storage facilities for a number of characters are provided so as to permit immediate repetition of any character which has been distorted in transmission, provided that a duplex circuit exists between the two radio terminals.

Transmission is by means of the seven-unit, three-mark code. Receipt of a character which has been distorted during transmission (giving wrong "mark" count) initiates a request for repetition. The number of characters held in the storage circuits is adjusted to suit the propagation time of the particular transmission path and is normally three or four characters. The "HU 20" series of equipments will operate with go-and-return propagation times of up to 450 milliseconds.

The basic equipment accepts two five-wire, five-unit synchronous signals from modified tape readers and produces a signal output using seven-unit code, with the two channels combined on an interleaving character basis suitable for direct-keying of the h.f. transmitters. The terminal comprises both transmitting and receiving equipment operating on a duplex basis. The received signal is decoded and the two channels separated. Where a duplex radio circuit is available, this provides two corrected teleprinter outputs operating on a single wire start/stop basis.



Testing "Autoplex" error-detecting and correction equipment at the maker's works

Industrial and Labour Notes

T.U.C. and the Budget

The general council of the Trades Union Congress has submitted to the Chancellor of the Exchequer a statement setting out suggestions for consideration in the preparation of the Budget. The T.U.C. view is that the Government should now aim to raise the general level of demand sufficiently to restore full employment and the expansion of industry. The existing margin of industrial capacity and the reserve of labour, the T.U.C. says, should permit a rise in production of 10 to 15 per cent in about two years and it is urged that demand should be stimulated towards that end.

The statement suggests that priority should be given to expanding industry in the public sector which has borne the brunt of the Government's deflationary measures during the past three years. Investment in the fuel and power and transport industries and on roads, the T.U.C. thinks, should be rapidly speeded up to provide an adequate basis for long-term industrial expansion. Other proposals set out in the statement include a reduction in long-term interest rates and a cut in purchase tax.

Prices and Wages

The thirty-ninth annual report of the British Employers' Confederation was presented yesterday at the Confederation's annual meeting in Glasgow. In a survey of the Confederation's work during 1958, the report comments that the domestic price level, as measured by the retail prices index, went up by under 2 per cent, a much smaller increase than for many years past. It might have been expected, in the light of economic circumstances over the year, the report says, that an even greater measure of stability would have been attained. Failure to attain this, it is claimed, must in large measure be attributed to the fact that wages continued to rise in a year in which production was at a somewhat lower level than in previous years. But, the Confederation adds, the lower tempo of industrial production and the small increase in unemployment over the year have almost certainly discouraged the practice of employers engaging in vigorous "bidding-up" between themselves by increases in wages and other financial benefits designed to attract labour.

Employment and Unemployment

At the annual meeting of Scottish members of the Federation of British Industries, in Glasgow on February 25, Mr. A. A. Shenfield, economic director of the F.B.I., urged the need to "keep a sense of proportion" about the current employment figures. A winter level of 2·8 per cent unemployment, he said, was much below anything considered to be full employment before "the madness of rip-roaring inflation" gripped the economy. To have maintained employment at well over 97 per cent in a period of structural readjustment of the economy was a great achievement, far better than could be shown, for example, in the U.S.A. and Canada, where percentage unemployment was much higher than in Britain.

Mr. Shenfield went on to emphasise that it was essential that any excess unemployment was temporary. Experience had shown, he commented, that the economy could be got on to an even keel with a good deal less unemployment than used to be thought. If there was some excess unemployment now, it was the price that was being paid for the excesses of inflation. Inflation, Mr. Shenfield asserted, always produced business which could not be maintained when the steam was taken out of it and, inevitably, some labour and some capital must be left high and dry for some time. What was encouraging, he continued, was that the volume left high and dry was so small in comparison with other times and other countries and that there was every reason for confidence that all could be re-absorbed. But, Mr. Shenfield added, that did not mean that all excess unemployment, which perhaps at most was a ½ per cent of the labour force, could be removed overnight. The beginning of the process would be to raise production by a fuller use of plant capacity, whereby the real incomes of the labour force would be raised. The absorption of the available labour would go on in parallel, but at a slower rate, and would be completed a little later. But, Mr. Shenfield suggested, that was a small price to pay for the establishment of a level of employment which was very high and yet did not need inflation to keep it going.

Long-Term International Capital

In the February issue of *Bulletin for Industry*, the Treasury points out that one of the most urgent demands of the post-war world has been for long-term international capital. The rapid political evolution of the under-developed countries, the *Bulletin* says, has been accompanied by an increasing awareness of the need for more rapid economic development. Unable to find sufficient investment funds at home, they have looked for them abroad, particularly in the more advanced countries. But these countries have had abnormal investment needs themselves. There was, first, the need to repair the ravages of war, not least in Western Europe. Secondly, there were the new scientific discoveries and developments, some dating from the war years, calling for new investment in the developed countries, for example, in atomic energy and the modernisation of basic industries and in automation and other new techniques in manufacturing industry.

The Treasury goes on to say that, throughout the post-war period, the United Kingdom has been an important source both of private capital and of Government grants and loans. In addition, certain under-developed countries—such as India and Pakistan—ended the war with extra large holdings of sterling reserves which they have drawn upon as an important source of development finance. The *Bulletin* explains that private capital movements to the overseas sterling area are not restricted by exchange controls. Policy on investment outside the area is generally to allow outward movements of capital for approved direct investment projects but not for portfolio investment. The net outflow of private capital from the United Kingdom has probably been on a rising trend over recent years, with an annual average of about £200 million between 1955 and 1957. This, the Treasury says, is also the average for the sterling area separately, the outflow to the rest of the world being almost offset by the inward movement. Grants and loans (including aid in kind and cancelled claims) totalled nearly £2000 million between the end of the war and March 31, 1958, about one-third of that total being in the form of loans. Measured against competing claims for funds at home, or against what has been done by other advanced countries during this period, the Treasury adds, the United Kingdom has made an impressive contribution to the development needs of other countries.

Average Earnings

The Ministry of Labour has published the detailed results of its most recent inquiry into average weekly earnings of manual workers in the manufacturing industries and in many of the principal non-manufacturing industries of the United Kingdom. The inquiry concerned the last pay week of October, 1958, and information was provided by about 67,000 establishments employing altogether approximately 7,000,000 manual workers.

The average earnings in the last week of October for all the industries covered by the inquiry were: men, £12 16s. 8d.; youths and boys, £6 12s.; women, £6 13s. 11d., and girls, £4 6s. 9d. In the manufacturing industries only, the earnings for that week were: men, £13 5s. 5d.; youths and boys, £5 9s. 1d.; women, £6 14s. 5d., and girls, £4 7s. 2d. This latter group includes, of course, "engineering, shipbuilding and electrical goods," the average earnings in which were returned as: men, £13 9s. 4d.; youths, and boys, £5 6s. 6d.; women, £7 7s. 10d., and girls, £4 11s. 7d. In all the industries covered by the inquiry, the percentage increases in average weekly earnings between April, 1947, and October, 1958, were: men, 108; youths and boys, 137; women, 99, and girls, 116. During the six-month period, April to October, 1958, the average increase for all workers was of the order of 1½ per cent.

The inquiry included also information about hours worked during the last pay week of October, 1958. In all the industries covered, these averaged: men, 64·6 hours; youths and boys, 30·1 hours; women, 39 hours and girls, 24·7 hours. In the manufacturing industries only, the comparable figures were 67·3 hours, 29·7 hours, 39·2 hours and 24·8 hours.

Iron Castings Production

The Joint Iron Council has stated that, in the final quarter of last year, the total output of iron castings, at 877,600 tons, was 15 per cent lower than in the comparable period of 1957. For last year as a whole, the total output (fifty-three weeks) was 3,468,600 tons, which was 8 per cent below the total reached in 1957. About the fourth quarter's operations, the Joint Iron Council's main comment is that continued trading weaknesses in many important industries which constitute a major portion of the market for iron castings explain the further decline in ironfounding production.

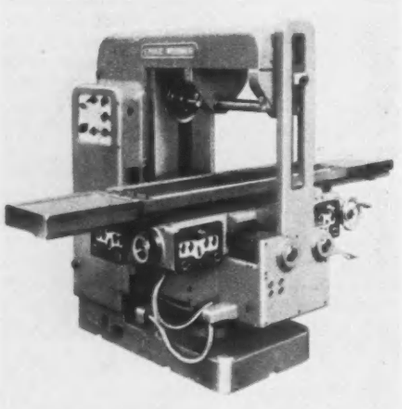
The Council directs attention to the fact that, in 1958, castings production for the automobile industry (including tractors) was at a record figure of 551,000 tons and, over the whole year, was 6 per cent higher than in 1957. But in all other sectors of industry the demand for iron castings declined. The Council says that at the end of last year the number of people employed in the ironfounding industry was 125,800, which was 8 per cent below the figure returned at the end of December, 1957.

Electrically Controlled Milling Machines

IN the course of a recent demonstration at the showrooms of the Rockwell Machine Tool Company, Ltd., Welsh Harp, Edgware Road, London, N.W.2, we saw some representative models of the new range of milling machines now made by Fritz Werner A.G., Berlin. This range includes horizontal, vertical and universal machines in a number of sizes with tables from 22in by 6in up to 102in by 20in, and most of them are available with either mechanical or electrical controls of all motions.

Of particular interest are the machines arranged for full electrical control, in which all the normal handwheels and levers have been replaced by push-buttons and directional finger levers grouped on small panels which are easily accessible to the operator. Typical of these machines are the horizontal and vertical models we illustrate: their operation calls for little or no physical effort, whilst fine settings and high production speeds can be achieved when working to precision limits in production. A comprehensive system of interlocking prevents misengagement of motions, and small latches situated by each directional switch can be set to prevent accidental engagement of a motion in the wrong direction.

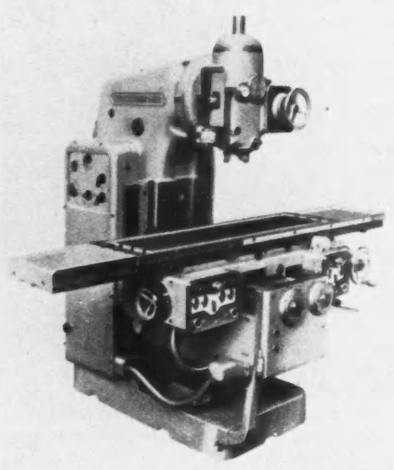
All of the slides are fitted with hydraulic clamps which are automatically applied when a slide is not in motion. Slide feed rates are set with reference to a graduated dial and for fine setting purposes the slowest feed rate is engaged. As a slide then moves its position can be continuously checked by reference to a rotating micrometer disc ; when the required disc setting is reached and the operator releases the directional switch, the slide is automatically and effectively instantaneously locked by its brake. This rapid slide clamping gives close control of accuracy when changing the direction of table feed and is claimed to make possible an accuracy within 0·0008in to 0·002in or even less when required on machines in the medium size range.



Horizontal milling machine with all motions controlled by push buttons and directional finger levers

If required, a machine can be fitted with automatic vertical and transverse cutter relief to prevent scoring of the work by the cutter on the return stroke. This cutter relief movement of about 0·004in takes place at the end of the feed stroke and before the automatic return stroke starts. The hydraulic slide clamping system works in conjunction with the cutter relief mechanism, and after completion of a rapid return movement the table is guaranteed by the makers to be within 0·0004in of its working position.

The motions of the machines are controlled through electromagnetic multi-disc clutches assembled in the form of easily fitted drums. These clutches are stated to have an indefinite working life and the only maintenance called for is the periodic replacement of the brushes. Like the solenoid valves controlling the hydraulic equipment on the machines, these clutches operate on a 24V supply.



Electrically controlled vertical milling machine with swivelling head

The spindles are fitted with electromagnetic brakes, and on the medium and larger models of the machines spindle speeds are controlled through a hydraulic gear shift. A spindle speed is selected whilst the spindle is stationary, and if the gears are not aligned for engagement a rocking device rotates the spindle backwards and forwards through a few degrees until the gears can move into engagement. This rocking movement serves to prevent damage to the leading ends of the gear teeth. It is imparted by a hydraulically-driven vane assembly on the spindle, to which pressure fluid is supplied when the gear shift hydraulic cylinder is unable to push the selected gears in mesh.

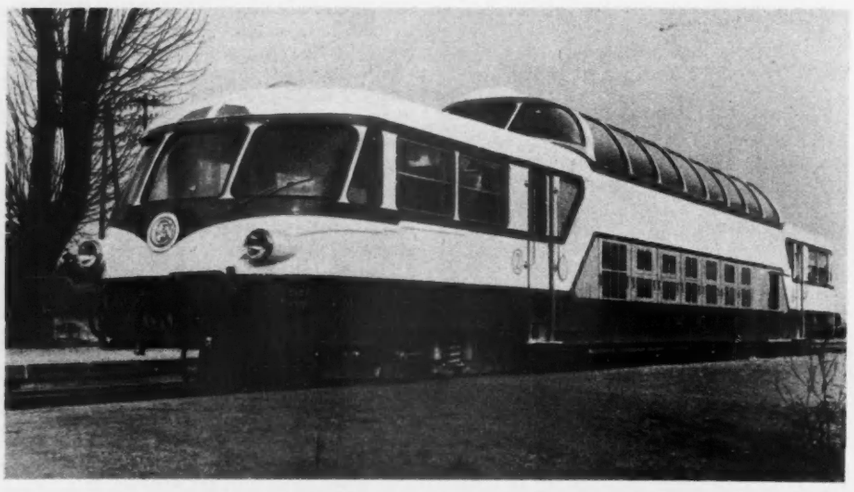
A switch panel is situated on the side of the column of these electrically controlled machines and through it seventeen different automatic table cycles can be set up. For this purpose selector switches on the panel are set in conjunction with a series of table stops which actuate limit switches at the required points in an automatic cycle. The makers have also introduced a special programme unit which can be used in conjunction with the electrically controlled machines. These units have a series of push-buttons arranged on interchangeable panels, and through the buttons a complete three-dimensional milling cycle can be set. A range of single and multi-spindle indexing attachments is also made for working in conjunction with the automatic table cycle, as well as magazine loading equipment for special applications.

French Observation Railcars

Ten diesel-electric railcars with passenger seating in observation compartments on two levels will be placed in service on scenic routes of the French National Railways this June. The lines on which the cars will operate are often steeply graded, and this fact, combined with the need to provide maximum passenger capacity, has resulted in the use of an 800 h.p. engine. Two bogie trailers can be hauled. Electric transmission has been installed because it allows better distribution of the vehicle weight of 55 tons. Plastics are used widely in the body construction in order to keep the weight as low as possible. The two-level design meets the unusual accommodation and power requirements while also affording easier access for maintenance than in a railcar with under-floor equipment.

Second-class accommodation is provided in the two end compartments, each seating twenty-two passengers. Wide windows provide unobstructed views in all directions. Seating is in individual chairs with armrests and headrests, placed for a view forward and rearward through the driving compartment windows. The first-class accommodation is on the upper level above the machinery compartment, from which it is insulated by a soundproof floor. The panoramic roof enclosing this section is built up entirely of plastics. The forty-four first-class armchair seats are reversible for either direction of travel and their backs and headrests are adjustable to reclining positions. In this section the windows are heated to assist in maintaining a comfortable temperature and to prevent misting. The side panes are lightly tinted blue to absorb infra-red radiation from intense sunlight. General heating throughout the vehicle is by the circulation of warmed air, the same circuit being used for ventilation in summer. In the first vehicle of the series a refrigerating plant has been installed experimentally for cooling the air before circulation in summer. Lighting is by fluorescent tubes. A luggage compartment is included on the lower floor of the body between the motor bogies.

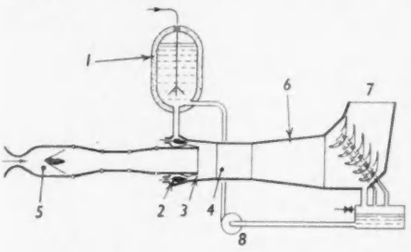
The railcars are being built by the Régie Nationale des Usines Renault, in co-operation with the Société Alsacienne de Constructions Mécaniques for the diesel engines and the Compagnie Electro-Mécanique for the electrical transmission. There is one motor in each bogie.



Diesel-electric railcar with two-level passenger accommodation for maximum visibility on scenic routes

Hot Water Ejector Wind Tunnels

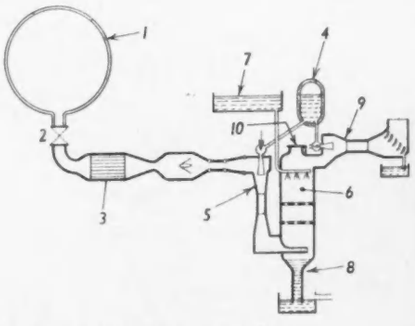
FOR some years work has been carried out by the Société Nationale d'Etude et de Construction de Moteurs d'Aviation (S.N.E.C.M.A.), Paris, directed towards developing induced flow high-speed wind tunnels. Originally these were driven by means of steam, while more recently hot water was injected. In a recently published paper* the mode of operation of the latter



1. Hot water accumulator
2. Needle valve.
3. Nozzle
4. Mixing section
5. Test section
6. Diffuser.
7. Hot water recuperator
8. Return pump

Fig. 1—Diagrammatic view of hot water tunnel

tunnel and its special advantages are described. Both the steam-blown and the hot water tunnel can maintain the high-speed flow for a longer period than the compressed air tunnel, a fact which is of particular interest in those cases where a certain time is required for a regime of flow to be established, as for instance in the testing of motors. The reason is that a steam accumulator can, for a pressure drop from 15 to 5 atmospheres, deliver 60 kg per cubic metre of steam compared with an air flow of only 9 kg per cubic metre under the same conditions. The speed of the steam is also higher than that of a geometrically similar air jet. It is pointed out, however, that for tunnels driven by steam



1. Compressed air container
2. Pressure reducing valve
3. Air reheater
4. Hot water accumulator
5. First ejector
6. Condenser
7. Cold water tank
8. Barometric water column (outlet)
9. Second ejector
10. Condenser lid

Fig. 2—Compressed air tunnel with two hot water ejectors arranged in series

ejectors, the optimum quantity of water in the steam accumulator at the commencement of running falls, say, from three-quarters to a quarter, as the rate of discharge is increased. The result is that this form of energy storage, efficient as it is compared to compressed air drive, becomes uneconomic, and as an alternative the use of hot water to drive the tunnel is advocated. The water is stored under pressure and a fraction flashes into steam in the nozzle: the very dense high-velocity stream of water and steam then energises the ejector. The velocity attained can, we understand, be inferred from the Mollier diagram: no indication of the optimum water temperature has been afforded us. If a source of heat is provided, the pressure in the accumulator can be maintained constant during a run, but a simpler plant in which it is allowed to fall during a run does not suffer any serious handicap in performance.

It is practicable to improve the efficiency of such a tunnel by extracting hot water from the exhaust: a set of turning vanes with slits to trap the moisture flowing over the surface will suffice, and between 20 and 30 per cent of the heat in the initial charge can be recovered, this figure increasing with the ratio of water flow to air flow, which tends to be 2 or more. A tunnel built on this principle is seen in Fig. 1: such a tunnel will run up to about Mach 3·4, and induction may take place through a dryer and/or a heater. By combining the ejector drive with a blow-down supply, there can be achieved very high Mach and Reynolds numbers or increased running times. Such a tunnel is shown in Fig. 2: it will be seen that it employs two ejectors in series, and that the working fluid of the first is separated out to a large extent by a jet condenser, thus improving the heat efficiency.

It is claimed that the saving in the initial cost of accumulators for a hot water tunnel may be 96 per cent of that of a steam tunnel, and thus far more extensive facilities can be realised: the time to start up and close down the tunnel will also be reduced, and the noise produced is significantly less. The presence of water in the exhaust renders this principle particularly attractive for engine test cells, in which there is a risk of explosive mixtures forming in the working chamber, and the water also serves to cool the tunnel walls.

* O. Frenzl: "Souffleries intermittantes à trompe d'induction par eau chaude," *Docaéro*, No. 51, July, 1958.

Large Surface Stress Tester

We have received details of the large surface optical stress tester made by Dr. Heinrich Schneider Optotechnische Fabrik, Bad Kreuznach, P.O. Box 260, German Federal Republic (U.K. agent, Nonius, Ltd., 38, Beethoven Street, London, W.10). Our illustration shows the Model I instrument with a field of vision of 500mm by 280mm (polariser) and an observation window (analyser) of 110mm by 110mm. It is

Testing a glass bottle for the presence of strains

stated that tests on transparent objects (glass or plastics) may be carried out by either the light-dark method or the colour-change method. In the first case, the colour of the test piece is of no importance. It is also possible to combine the two tests, in which case two-dimensional strains can be determined with an accuracy quoted as ±10 per cent. The test object, by virtue of the large analyser, can be viewed with both eyes, and a set of polarising glasses can be supplied for use by a second observer. The instrument is mounted in a carrying case and is normally supplied for connection to 220V a.c.

For precision measurements in experimental stress analysis, the Model II tester has been developed which has a visual field of 400mm diameter. The analyser can be used as a Senarmont compensator, so that it is possible to measure the amount of binary stress refraction directly without the need for photographic evaluation. Whenever photographs are to be taken, however, the intense light source is stated to be of great help. Tests can be carried out with either plane or circular polarised light, and white or monochromatic (sodium vapour) light. The analyser is mounted on a separate stand, so that great flexibility in setting up the test is achieved. The instrument, for connection to 220V mains, is mounted in a carrying case.

Illuminated Weather Indicator

Weather forecasts for the next twelve hours are now being signalled from the top of the 40m high Aachen town hall. This is done by means of an illuminated sphere of 2·25m diameter mounted on an 11m-high tripod mast. Simple code signals are employed, using "blue" for fair weather, "yellow" for overcast, and "white" for rain or snow. Semi-circular fluorescent tubes of these colours are arranged in six groups of six along equidistant meridians on the sphere. In addition, white fluorescent tubes are fitted to the legs of the mast.

Steady weather is indicated by constant illumination, changeable weather by flashes. If the temperature is likely to remain constant, the pattern of lights on the tripod remains stationary; a "rising" or "falling" pattern indicates the direction of probable change. The installation, built by Siemens-Schuckertwerke A.G., Berlin-Erlangen, is stated to follow an American idea. The control switches are actuated by high-resistance relays over a telephone line from the exchange which receives the forecast from the meteorological station. A direct connection is to be installed later.

Swedish Chipboard Factory

A chipboard mill for an output of 16,000 tons, or 29,000,000 square feet per annum, was opened late in November at Åryd, near Växjö, in the South-Swedish forest province of Småland. The new mill, said to be Sweden's most "automatised" wood-processing factory, is also the country's largest of its kind and will make Sweden an exporter of chipboard: Sweden previously had to import considerable quantities of this product.

During the past few years chipboard has been adopted on an ever-increasing scale, particularly in the furniture industry, shipbuilding and the building industry. The board will be made according to the German Behr system, for which the manufacturers have acquired the sole rights in Sweden.

The Åryd plant is owned by Skogsägarnas Industri A.B. (S.I.A.B.), a subsidiary of Sydöstra Sveriges Skogsägares Förbund (the South-East Swedish Forest Owners' Association). By engaging in this production the Association has aimed at supplementing its large industrial activities and also at finding use for part of the smallwood in its area, which covers 2,500,000 acres of productive forest land, owned by 22,000 individual proprietors. The Association has 3200 employees and total sales from its industrial undertakings amount to some £10,000,000 per annum. A planned addition to its chain of industries is a sulphate mill at Mörrum, with a capacity of 140,000 tons a year.

Progress of the Tennessee Valley Authority

BY OUR AMERICAN EDITOR

No. I

THE fiscal year 1958 of the T.V.A. may be considered to mark two important anniversaries : the golden jubilee of the national conservation movement in the United States, dating back to President Theodore Roosevelt's Conference on Conservation in May, 1908, and the silver jubilee of the T.V.A., as initiated by the Tennessee Valley Authority Act of 1933. Over the years, the work of the Authority has continued to provide a splendid example of the benefits obtainable from properly co-ordinated conservation schemes. The transformation of the Tennessee River was accomplished by the building of multiple-purpose dams, planned and placed with precision in the valleys and gorges of a watershed of 41,000 square miles. The subsequent transformation of the power system from a predominantly hydro-electric enterprise to principal reliance on steam was accomplished by the construction of new large steam power stations, mainly in response to the demand for electricity for national defence.

Construction activity in 1958 followed much along the pattern of the past. A new, large lock was taking shape at the Wilson dam in northern Alabama to make the river more useful to commerce. Steam generating units were being added at four steam power stations to serve the growing needs of homes, farms, businesses and industries. In the years since 1933, T.V.A. has built twenty dams and eight large steam-electric power stations, many on emergency schedules, to help the Tennessee Valley region and the country throw the full weight of their resources into peacetime economic development and "hot" and "cold" war emergencies. It is safe to say that the size and number of engineering works in the Tennessee Valley region have far exceeded the expectations of those who conceived the T.V.A. Act. National and world events undivined in 1933 have shaped the character and tempo of the development. What started out as the comprehensive development of a major river system in the tradition of the conservation movement of the early 1900s was found capable of responding quickly and effectively to extraordinary and changing demands. To recapitulate: in 1933, T.V.A. commenced the construction of two dams, Norris and Wheeler. Two years later starts were made on the Pickwick Landing and Guntersville dams. When the Norris and Wheeler dams were closed in 1936, construction shifted to the Chickamauga and Hiwassee dams. In 1938, 1939 and 1940 starts were made on the Kentucky, Watts Bar and Fort Loudoun dams. The latter was the last of seven main river dams proposed for construction in a special report to the Congress in 1936.

To carry on this orderly progression of building, T.V.A. not only organised its own engineering and design staffs but undertook construction with its own labour force and construction organisation. Thus, by the time World War II began, a stable, experienced organisation had developed which could be efficiently expanded to meet new needs and conditions. The first defence need came in 1939, when the United States embarked on a build-up of its national defences. In 1940, construction of the Cherokee dam and the Watts Bar steam power station was

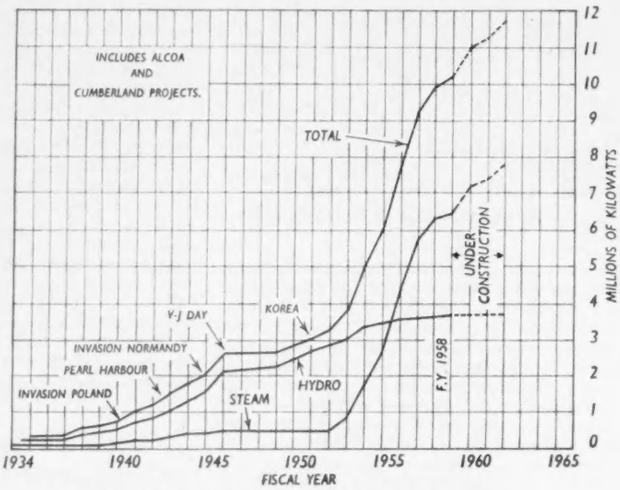
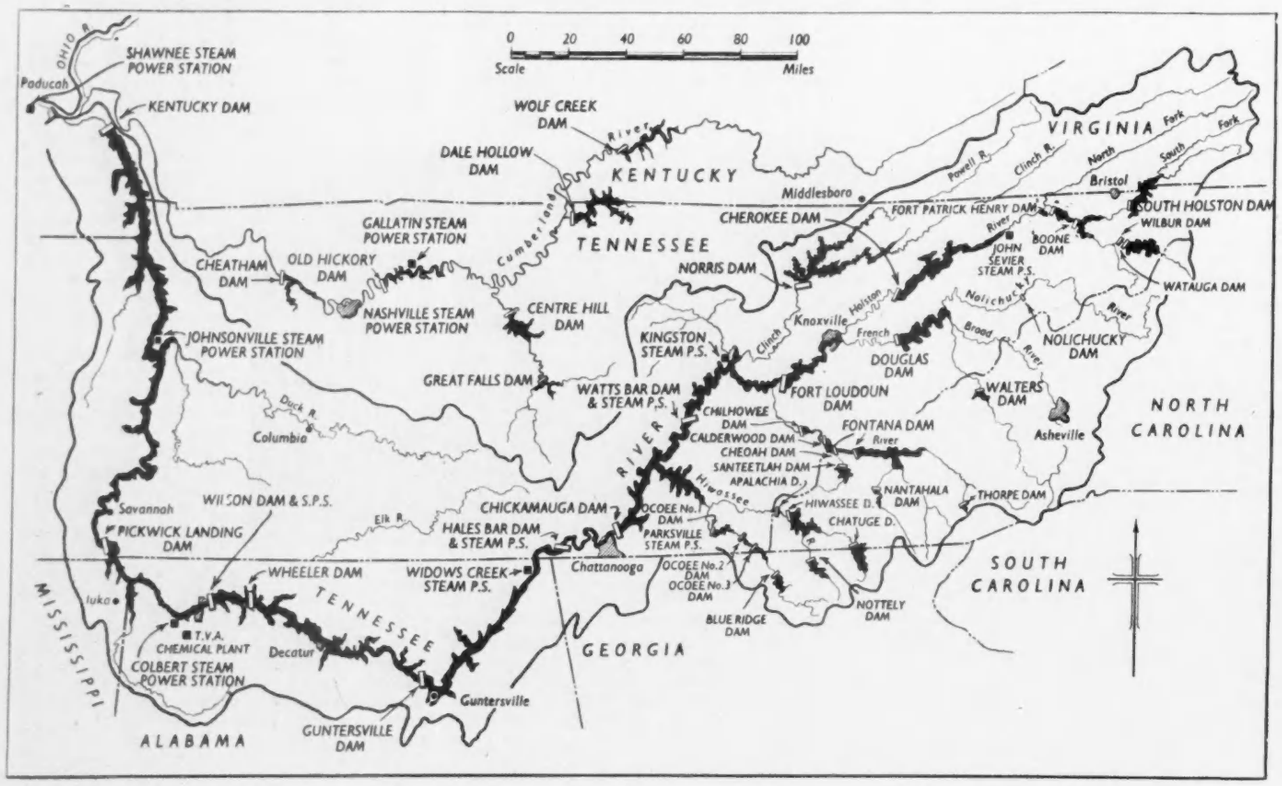


Fig. 2—Development of the T.V.A. generating capacity



Dam	Miles above mouth	Height of gates above sea level, feet
Kentucky	22	375·0
Pickwick	207	418·0
Wilson	259	507·9
Wheeler	275	556·3
Guntersville	349	595·4
Hales Bar	431	635·0
Chickamauga	471	685·4
Watts Bar	530	745·0
Fort Loudoun	602	815·0

Fig. 1—Map of the Tennessee Valley region with sites of hydro-electric and steam power stations

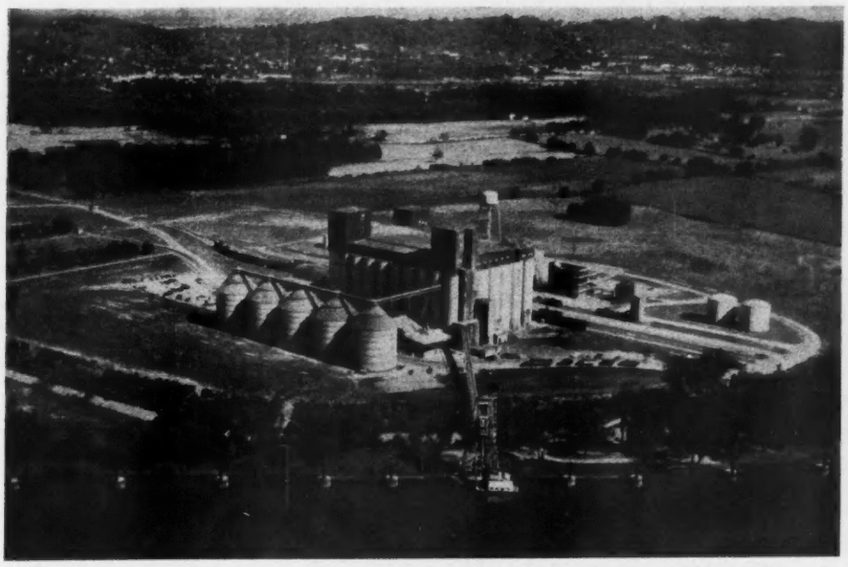


Fig. 3—Grain processing works of the Central Soya Company on the Tennessee River at Chattanooga, Tennessee

commenced, both keyed to providing additional power for industries essential to military supply. In 1941, before Pearl Harbour, construction was started on four additional dams on the Hiwassee River system. After Pearl Harbour, the Douglas and Fontana dams were begun. A new requirement for power came from the "Manhattan Project," the then-secret atomic development at Oak Ridge, Tennessee. By early 1942, twelve dams and the steam power station were under construction and employment peaked at 42,000 workers. Ten of the dams were completed by the end of the war. Work on the other two was suspended during the war by the U.S. War Production Board. Records were set and broken. Where the Norris dam had taken three years to build, Cherokee was closed in sixteen months. The value of an experienced engineering and construction organisation "in being" was particularly exemplified in the construction of the Douglas dam. Designs for Cherokee on the Holston River were adapted to the Douglas project on the French Broad. The Cherokee engineering and construction forces were moved to the new site. In slightly more than twelve months, the Douglas dam was closed and a month later was producing power, while the storage its reservoir provided increased the power capacity at dams downstream. The Fontana dam on the Little Tennessee River was built in three years, compared with a peacetime schedule of five or six years.

As shown in Fig. 2, the installed generating capacity grew rapidly. At the time of the invasion of Poland, the system had less than 750,000kW of capacity; when Pearl Harbour was bombed it was 1,065,000kW. By the time Japan surrendered on August 14, 1945, the installed capacity of the system had reached 2,507,000kW. Although electric power was the primary consideration in construction during the war, the emergency schedules speeded the completion of other resource developments. The closure of the Kentucky dam in August, 1944, provided the last link in the Tennessee 9ft waterway. By the end of the war 10,000,000 acre-feet of flood storage had been provided.

Rapid construction during the war had developed most of the major hydro-power sites in the Valley. All the dams on the main stream had been built. On the tributaries, two dams started during the war were completed and two more planned and completed by 1953. Coal burning steam power stations were commenced to help shoulder the increasing power load. The second, and greater, surge of construction began in 1950 with the invasion of South Korea by Communist forces. To meet the vast demands for electricity at the expanded Oak Ridge plant of the A.E.C. and its new plant at Paducah, Kentucky, T.V.A. turned to the construction of large steam-electric power stations. Between the time of the outbreak in Korea and July, 1953, the Congress approved funds for 5,164,000kW of installed capacity, most of it for the purpose of supplying the atomic energy plants. Because of the size of the system and the size of the impending loads, T.V.A. was able to progress toward larger and larger generating units, with increased efficiency. Thus the initial units at Johnsonville and Widows Creek were of 112,500kW capacity. The ten Shawnee units and the first of four Kingston units were 135,000kW. At the Colbert, Kingston and John Sevier power stations, unit capacity went up to 180,000kW and at Gallatin to 225,000kW and 247,500kW. The latest unit was started in the 1957 fiscal year, will have a capacity of 500,000kW and is being installed in the Widows Creek steam power station. Between the end of fiscal year 1951 and June 30, 1958, the installed generating capacity was more than tripled—from 3,181,110kW to the present 10,222,210kW.

As shown in Fig. 1, the water control system on the Tennessee River and its tributaries now consists of thirty-one major dams, of which nineteen are multiple-purpose structures embracing flood control, navigation, and power features. The other twelve are single-purpose power projects. These thirty-one include the twenty dams built by T.V.A., the Wilson dam built by the U.S. Government during World War I, and four dams purchased by T.V.A. from private interests. Linked with these by agreement as an integral part of the system are six major hydro-electric projects owned by the Aluminum Company of America. The system provides a total of nearly 14,600,000 acre-feet of useful, controlled storage. By storing much of the excess rainfall and run-off in heavy storms and regulating the flow through the main-river dams, the system reduces damaging flood crests and achieves other flood control benefits. The navigation channel created by the system extends 650 miles from the head-of-navigation at Knoxville, Tennessee, to the junction of the Tennessee and Ohio rivers, becoming an important link in the 10,000-mile inland waterway system of the United States. Beside the main channel, the reservoirs provide 225 miles of feeder channels, some of them used by commercial as well as recreation craft.

The generating facilities of the power system include, in addition to the hydro-electric power stations at the dams on the Tennessee and its tributaries, five dams on the Cumberland River system, eight steam-electric power stations built by T.V.A., and seven small acquired power stations. Of the Cumberland River dams, one was purchased by T.V.A. and the others were constructed and are operated by the U.S. Army Corps of Engineers for flood control, navigation and power generation. Electricity from the Army dams is distributed to consumers through the T.V.A. power system. Of the 10,222,210kW installed capacity of the integrated power system at the close of the 1958 fiscal year, 6,494,750kW was in steam power stations, mostly built to serve the needs of national defence, and the remainder in hydro-electric projects.

River Navigation

In the perspective of history, the twenty-fifth anniversary of T.V.A. may mark a point of transition between the formative years of Tennessee River development and a period of accelerated economic growth. From the establishment of T.V.A. in 1933, the river has been providing electric power. Navigation also came

Fig. 4—Synthetic fibre works of the Chemstrand Corporation on the Tennessee River at Decatur, Alabama

gradually as the dams with their locks were thrown across the mainstream and dredges scooped out the shallows along the waterway. By 1943 a 6½ft depth was achieved over the length of the river. By 1952, the entire 9ft project was complete with 11ft of depth for barges drawing 9ft and a 300ft minimum width.

The waterway, now extending 650 miles from Knoxville to the Ohio, provides an economical supplement to established land-borne commerce, which also invites new traffic, generating in many instances new business in conjunction with new industry. Notable as an example is the rise in grain movements into the Valley region from the Middle West. As farmers have diversified their operations, supplementing row crops with pasture agriculture and producing animal products and poultry, the demand for feed grains has brought a steadily increasing flow of barge grain traffic to Tennessee River ports. Flood-free sites and a dependable waterway alone are not necessarily the determining factors in an industry's decision to place a factory. Management thinks of labour supply, raw materials, markets and, in some cases, availability and cost of electric power. But the unmistakable trend in private plant investment along the Tennessee gives strength to the belief that the river resource is one of the most valuable in the region and its real potential is as yet undetermined. The following tabulation indicates the growth of private investment in Tennessee River front industries over the last twenty-five years :—

Period	Amount of investments, dollars
1933–1945, inclusive	8,000,000
1946–1950, inclusive	46,000,000
1951–1955, inclusive	307,000,000
1956 to date...	313,000,000
	674,000,000

The development of the river has created a number of additional channels of potential development not fully envisioned by the founders of T.V.A. Control of the river has brought a huge recreational industry into being, a teeming fish and wildlife development, and improved water supplies for municipal and industrial use. Between the industries with their docks and terminals, along the lake shores are state, county and city parks, recreation boat docks and fishing camps, resort areas and cabin settlements, wildlife refuges, public hunting areas and malaria control works, in addition to many acres of useful agricultural and forest lands.

Commercial freight traffic on the Tennessee has developed faster than on other major rivers of the 10,000-mile inland waterway system. According to American Waterways Operators, Incorporated, the Tennessee showed a 467 per cent increase in ton-miles and a 340 per cent increase in tonnage between 1947 and 1956. This was nearly double that of the nearest rival river, the Missouri. Several circumstances have contributed to this result. In 1933, there was little freight traffic on the Tennessee—only 33,000,000 ton-miles. The river was not really navigable as a dependable transport artery. Despite sporadic attempts at improvement, the controlling low water depths ranged from 4ft between the mouth of the river and the Wilson dam and 1½ft upstream from Chattanooga. To-day, the 650 miles of channel from the Ohio to Knoxville has a guaranteed depth. It is marked by the U.S. Coast Guard for both day and night navigation. Slack water lakes ease the effort of up-bound tows, and safety harbours are placed at regular intervals in case of storm or emergency. The channel is favourably situated with the climate permitting year-round navigation. Economic conditions have been favourable. Traffic was stimulated by World War II, when large tonnages of defence equipment and materials began to move on the still incomplete waterway. The prosperous post-war economy brought new industrial plants. With the increased demand for power for defence, coal for steam power stations became the major commodity moving on the river, amounting to half the tonnage in 1957.

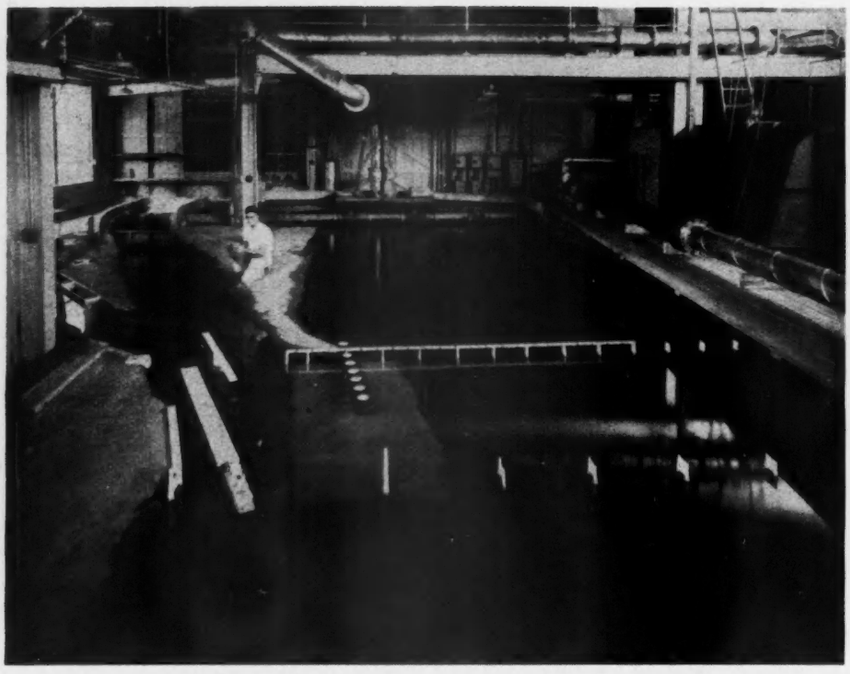


Fig. 6—1 : 100 scale model of the Florence canal leading to the new Wilson dam lock under investigation to determine navigational features

In the calendar year 1957, preliminary figures show that more than 12,700,000 tons of freight moved 2100 million ton-miles on the river. These figures represented increases of 3·5 and 5·5 per cent respectively, over 1956. The estimated savings amounted to 21,500,000 dollars, as compared with about 4,000,000 dollars of cost to the Federal Government for operating the waterway. This consists of T.V.A. costs, including depreciation, and costs of the Corps of Engineers which operates the locks and the U.S. Coast Guard, which marks the channel. The margin of 17,500,000 dollars over costs is equal to a return on the net navigation investment of nearly 13 per cent. It appears that the traffic for 1958 will about equal that of 1957. In the first six months of the year, decreased shipments of coal and of stone, sand and gravel were offset by shipments of long-haul commodities such as aluminium, grain and grain products, molasses and phosphate rock. Grain movement is the fastest growing of all commodity traffic on the river at the present time.

The shores of the Tennessee waterway provide many excellent sites for industrial works on flood-free, relatively flat lands. The private investment in riverside industries since 1933 has been in over 100 works and terminals. Over 90 per cent of it has taken place since 1950 and more than 45 per cent in the last three years. In the past year, four new feed mills were constructed at Guntersville, the southernmost port on the Tennessee. A river terminal for the

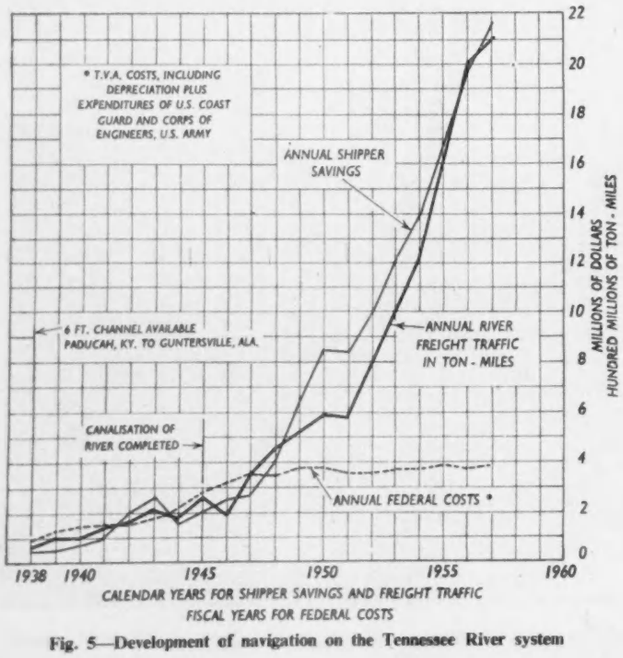

* T.V.A. COSTS, INCLUDING DEPRECIATION PLUS EXPENDITURES OF U.S. COAST GUARD AND CORPS OF ENGINEERS, U.S. ARMY
ANNUAL SHIPPER SAVINGS
6 FT. CHANNEL AVAILABLE PADUCAH, KY. TO GUNTERSVILLE, ALA.
ANNUAL RIVER FREIGHT TRAFFIC IN TON - MILES
CANALISATION OF RIVER COMPLETED
ANNUAL FEDERAL COSTS *
MILLIONS OF DOLLARS HUNDRED MILLIONS OF TON - MILES
0 2 4 6 8 10 12 14 16 18 20 22
1938 1940 1945 1950 1955 1960
CALENDAR YEARS FOR SHIPPER SAVINGS AND FREIGHT TRAFFIC
FISCAL YEARS FOR FEDERAL COSTS

Fig. 5—Development of navigation on the Tennessee River system

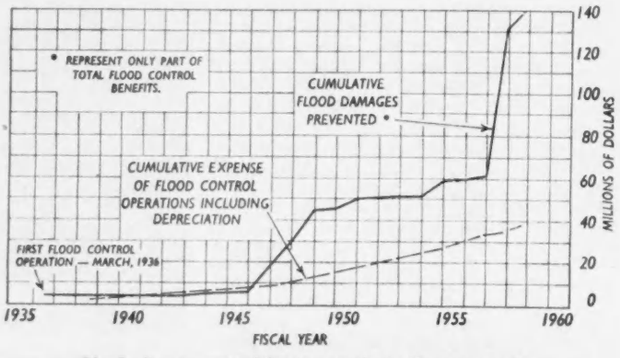

* REPRESENT ONLY PART OF TOTAL FLOOD CONTROL BENEFITS.
CUMULATIVE FLOOD DAMAGES PREVENTED *
CUMULATIVE EXPENSE OF FLOOD CONTROL OPERATIONS INCLUDING DEPRECIATION
FIRST FLOOD CONTROL OPERATION — MARCH, 1936
MILLIONS OF DOLLARS
0 20 40 60 80 100 120 140
1935 1940 1945 1950 1955 1960
FISCAL YEAR

Fig. 7—Development of flood control in the Tennessee Valley

Fig. 8—Actual confluence of the main Tennessee River and the Florence canal now under construction near Wilson dam

receipt of package and bulk flour was built at Chattanooga. The Alabama State Docks Department, which is building several terminals along the Tennessee, is adding grain elevators at its Huntsville and Decatur installations on which construction started during the year. Navigation was one of the factors which led the Bowaters Southern Paper Company to place a paper and pulp factory on the Tennessee waterway, in which investment now exceeds 100 million dollars. The last Congress modified a restriction against the operation of towboats and barges on United States inland waterways by foreign corporations in order that Bowaters, a British company, might use its own equipment in transporting raw materials and finished products.

Flood Control

Although there were no large floods as in the previous fiscal year, the multiple-purpose system operated to regulate two lesser floods and averted nearly 9,000,000 dollars in damage. In May, 1958, the system reduced the crest of a flood on the lower Ohio and Mississippi rivers at Cairo, Illinois, by more than 3ft. The reduction forestalled an estimated 8,000,000 dollars in damage, chiefly on croplands unprotected by levees. In November, 1957, a flood occurred which would have been the highest on record for that month all the way from Chattanooga to the Kentucky dam. At Chattanooga, the crest was reduced by 7·2ft and savings in damage averted amounted to about 710,000 dollars.

Flood control operations have dated from 1936, when the Norris dam was placed in operation. However, the system has been in essentially full operation only since 1945, when the Kentucky dam was completed. Since 1936 the system has regulated more than twenty floods that would have caused damage at Chattanooga. These included the flood of February, 1957, which, without regulation, would have been the second highest ever recorded at that point. It would have come within 4ft of the highest flood ever recorded, that of 1867. The reservoir system reduced this flood by 22ft, averting about 66,000,000 dollars of damage. Included also were floods in 1946, 1947 and 1948 which would have ranked fifth, sixth, and seventh among recorded floods. Their crests were reduced 10ft to 12ft 6in. The damage averted at Chattanooga now exceeds 120 million dollars. Outflow from the Tennessee River has also been controlled to reduce floods on the lower Ohio and Mississippi rivers in prior years as much as 3ft, with consequent savings in damages of more than 20,000,000 dollars.

The total of flood damage averted at Chattanooga and on the lower Ohio and Mississippi rivers now exceeds 140 million dollars. This total is equal to about 75 per cent of the total investment of 184 million dollars in flood control facilities. The figure does not fully represent the total of damages prevented, however. Although Chattanooga is the most vulnerable point in the Valley, the system in any sizeable flood also prevents substantial damage at other towns and cities along the river system and protects substantial areas of valuable agricultural lands. Damages prevented in these areas are not included in the flood savings estimates. In addition, benefits in the form of increased land values due to greater security from floods to areas behind the levees on the lower Ohio and Mississippi rivers are estimated at 150 million dollars. These benefits were provided upon the completion of the Kentucky project in 1945.

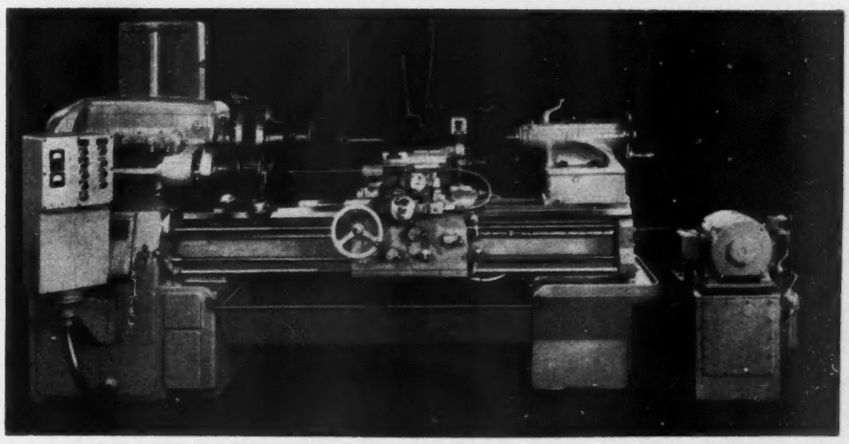
In the fiscal year 1958, T.V.A. prepared reports on flood conditions for ten communities in the Valley, to assist them in planning for flood damage prevention. This was a continuation of a programme started in 1953 which, it is believed, can have valuable nation-wide application. It is a co-operative programme with state planning agencies and local communities. The programme grew out of the fact that the T.V.A. system of dams and reservoirs, designed to provide regional control of major floods in the Tennessee, Ohio and Mississippi River basins, does not provide flood protection for communities located upstream from the reservoirs, nor does it eliminate all flood problems at downstream communities. In many communities, small unregulated streams and local conditions aggravate flood dangers. T.V.A. engineers prepare reports at the request of the communities, made through their state planning agencies, outlining the flood situation for each community. They provide data on floods of the past as well as defining floods which may reasonably be expected to occur in the future. The reports are based on data collected as a part of the work that T.V.A. has been carrying out in connection with its water resource operations throughout the Valley.

Rotary Profile Tracer Lathe

The boring of bottle moulds having non-circular cross section is accomplished much faster than possible heretofore and with improved accuracy on a new rotary profile tracer lathe developed by the Monarch Machine Tool Company of Sidney, Ohio. The machine will accommodate most bottle mould work and it may readily be used for all conventional turning, boring and threading operations. The machine employs a very sensitive electro-hydraulic tracer, the head of which is built into a bar that is adjustably mounted at the front of the cross slide. The stylus deflection pressure is only 1½ oz, and electrical amplification of stylus movement instantly translates the slightest work contour change into hydraulic slide movement. The accuracy of reproduction is such that later hand finishing operations require only a fraction of the time previously necessary.

At a feed of 100in per minute, the accuracy of duplication of the tracer slide is ±0·001in. The maximum tracer slide stroke at one setting is 4in. Tool adjustment for diameter is made by means of a slide mounted between the tracer slide and the swivelling tool slide. The latter is set parallel to the work axis for length adjustment of the tool. The cross slide is provided with automatic pressure lubrication. For convenience of set-up and operation, the master spindle is situated at the front of the machine. There is a positive gear drive from the headstock spindle through a quadrant-mounted idler which may be adjusted to remove all backlash between the lathe spindle and the master. A timing device on the master spindle is provided for angularly positioning the master mould and the workpiece.

A female or a male master can be used. With the master spindle locked stationary, a half mould or a conventional flat template may be used to guide the tool for boring or turning. Because of the light stylus pressure, non-metallic materials may be used as masters.



Monarch rotary profile tracer lathe for the boring of bottle moulds of non-circular cross section

Personal and Business

Appointments

MR. C. B. EVANS has been appointed a director of Midland Silicones, Ltd.

MR. H. G. STAGE and Mr. F. Tomkins have been appointed directors of Nu-Swift, Ltd.

MR. J. R. HUGHES, A.M.I.E.E., has been appointed a director and commercial manager of Hivac, Ltd.

DR. CECIL PEPPER, F.R.I.C., has been appointed managing director of Alexander Duckham and Co., Ltd.

MR. F. L. LAMBERT has been appointed assistant civil engineer of British Railways, London Midland Region.

MR. L. M. CHARLTON has been appointed assistant naval architect, Canadian Pacific Steamships, at Liverpool.

MR. B. G. FITZSIMON has been appointed production engineer at the Brighton plant of West Instrument, Ltd.

MR. H. M. CURRIE has been appointed to the post of marine branch manager in London for Mobil Oil Company, Ltd.

THE CONSOLIDATED PNEUMATIC TOOL COMPANY, Ltd., has announced the appointment of Mr. Gordon L. Dray as manager of the oil division.

AERO CONTROLS, Ltd., Northampton, has announced the appointment of Mr. W. H. Haydon-Soutar, A.M.I.Mech.E., as chief engineer.

THE VILLIERS ENGINEERING COMPANY, Ltd., has appointed Mr. Herbert G. Sealey as service superintendent in succession to Mr. Kenneth Wilkes.

GEORGE KENT, Ltd., has announced that Mr. J. F. Willsher has been appointed general works manager following the retirement from active duty of Mr. J. Horridge.

MR. T. F. HURLEY, who recently retired from the position of chief research engineer at the Fuel Research Station, has now joined the National Industrial Fuel Efficiency Service.

MR. F. L. WILLS has retired from the position of managing director of the Hunting Aerosurveys group of companies. He has been succeeded by Mr. T. D. Weatherhead. Mr. Wills remains on the board of directors of Hunting Aerosurveys, Ltd.

MR. W. F. STONES, F.R.I.C., chemist in the north-eastern division of the Central Electricity Generating Board, has been appointed regional research officer for the north-eastern and Yorkshire region.

THE STEEL COMPANY OF WALES, Ltd., has announced that Mr. W. G. Mainwaring, formerly deputy hot mills manager, has been appointed sheet mills manager in succession to Mr. J. H. Lysaght.

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY has appointed Dr. Nyman Levin to be director of the Authority's weapons group. He has been succeeded as deputy director of the weapons group by Mr. E. F. Newley.

THE CHAMBER OF SHIPPING OF THE UNITED KINGDOM announces that Sir Nicholas Cayzer, Bt., the chairman of the British and Commonwealth Shipping Company, Ltd., has been elected president and that Mr. Hugh Hogarth, a director of H. Hogarth and Sons, Ltd., has been appointed vice-president.

CROMPTON PARKINSON, Ltd., announces that Mr. G. H. Armstrong, A.M.I.Mech.E., has been appointed chief production engineer for the Southern Works of the Crompton Parkinson group of companies, and has been succeeded as production engineer at Crompton Parkinson (Chelmsford), Ltd., by Mr. G. Cubitt-Smith.

SAMUEL FOX AND CO., Ltd., has announced that in consequence of Mr. Billington's move to Steel, Peech and Tozer, Mr. G. Thickett will assume direct charge of the billet mill for the remainder of the year from March 1, 1959, whilst continuing to carry out his normal duties as works manager, heavy departments. Mr. J. D. Heys has been appointed work study officer.

WORKINGTON IRON AND STEEL COMPANY has announced the retirement from the board, and from the boards of other subsidiary companies of the United Steel Companies, Ltd., of which they are members, of Mr. J. N. St. George Curwen, Mr. Langton Highton and Mr. D. R. Wattleworth. Mr. T. Sanderson, general works manager, and Mr. J. Laird, commercial manager, of the branch, have been appointed directors of the Workington Iron and Steel Company.

STEEL, PEECH AND TOZER announces the following rearrangement of the works managerial structure :—Mr. H. R. Brunyee to be works manager, services ; Mr. C. H. Hayter to be works manager, Templeborough ; Mr. R. Scholey to be works manager, Ickles ; Mr. W. E. Alexander to be technical assistant (mills) to the works manager, Templeborough ; Mr. D. R. Baker to be technical assistant to the works manager, Ickles ; Mr. D. E. Billington to be manager, cogging, billet and bar mills, including the 10in and 14in mills ; Mr. E. Houghton to be assistant to the works manager, Templeborough ; Mr. M. Thomas to be assistant to the works manager, services ; Mr. E. A. Judd to be manager, spring shops and drop stamp ; Mr. I. Ross to be manager, instrument department.

Business Announcements

HALL HARDING, Ltd., Stourton House, Dacre Street, London, S.W.1, announces that it has opened a new branch at Gladstone Buildings, Bishop Street, Leicester.

R. G. MCLEOD TOOLS, Ltd., Lavina Grove, London, N.1, states that Hoskins "Chromel" and "Alumel" thermocouple wires are now available on a "same-day" delivery basis.

BROOM AND WADE, Ltd., has recently formed in Belgium a merchanting company, Broomwade-Belge S.A. The directors are Mr. H. S. "Dick" Broom, M.I.Mech.E., Mr. C. Broom Smith and Mr. J. E. Bambrough.

BRITISH ENGINEERS SMALL TOOLS AND EQUIPMENT COMPANY, Ltd., announces that Lieut.-Colonel T. Child, M.I.Mech.E., has relinquished the position of director and chief executive, after nine years' service. Mr. Arthur Child, the present secretary, is also acting manager of the company. Mr. Mark H. Taylor, M.I.Mech.E., is rejoining the board of directors.

METAL INDUSTRIES, Ltd., announces that it has formed a new company, Brookhirst Igranic (Europe), Ltd., 62, Rue Joseph II, Brussels, to co-ordinate the European activities of its electrical subsidiary, Brookhirst Igranic, Ltd. Directors of the new company are Mr. John Black, chairman ; Mr. H. Derboven, deputy chairman ; Mr. R. H. Frings and Mr. H. O. Houchen.

HERBERT MORRIS, Ltd., Loughborough, has acquired the British and American shares of British MonoRail, Ltd., Wakefield Road, Brighouse, Yorks. Mr. Frank Morris, chairman of the Herbert Morris, Ltd., group of companies, has been appointed chairman of British MonoRail, Ltd., and Messrs. E. Russell and G. Randsley, directors of Herbert Morris, Ltd., have also been appointed directors of British MonoRail, Ltd.

Contracts

JOHN I. THORNYCROFT AND CO., Ltd., has received an order from J. P. Knight and Co. for a tug to be equipped for fire-fighting and salvage duties. The vessel will have a length overall of 120ft by 28ft breadth moulded, a draught of 14ft 9in, and will be powered by a British Polar diesel engine of 1500 b.h.p.

RICHARD COSTAIN, Ltd., in association with Raymond International, Inc., has been awarded a contract valued at £8,000,000 for the construction of a 6-mile long breakwater and a separate island breakwater in the Bight of Bonin, Nigeria. The work will take six years to complete. The purpose of the breakwater is to protect a dredged channel off the mouth of the Escravos River, to permit ships with a draugnt of 20ft to enter the river on the way to the Delta ports. Stone will be quarried more than 150 miles up-country, and will be brought 27 miles by road to a wharf, where it will be loaded into barges and carried 130 miles along creeks to Escravos. There it will be transhipped into sea-going barges for delivery to a mobile island platform which will be working between 1 and 6 miles offshore. The contract will necessitate the building of complete townships at Ore and Escravos. The consulting engineers are Messrs. Coode and Partners, and the project is being carried out for the Nigerian Government.

Miscellanea

MEASUREMENT EXHIBITION IN MANCHESTER.—An exhibition is to be held by Taylor, Taylor and Hobson, Ltd., of Leicester, in the Cheetham Public Hall, Cheetham Hill Road, Manchester, 8, from March 16 to 21 next, when a comprehensive range of the firm's optical and electronic instruments, machine tools and photographic lenses, will be displayed. The exhibits will include a new "Talyrond," which has been designed to provide measurement of components that do not justify the larger capacity of the model 1 machine, and a "Micro" alignment telescope, as well as a new copying, profiling, routing and milling machine, and an engraver/miller.

TIMBER SHELL ROOFS.—In last week's issue of THE ENGINEER, a short note with the above title gave details of some timber shell roofs constructed as hyperbolic paraboloids. This type of surface was then described, surprisingly, as "a surface of involution which has straight line generations," a phrase which should, of course, have read "a surface of revolution which has straight line generators."

MACHINE TOOL DEMONSTRATION.—It is announced by Hayes Engineers (Leeds), Ltd., Gelderd Road, Leeds, 12, that for five days commencing March 16 next demonstrations will be given at the Birmingham Engineering Centre of the "Tracemaster" automatic copy milling machine and a "Diemaster" universal die and mould milling machine. Tool-making firms are invited to attend the demonstration and take suitable work, problems concerned with which can be discussed with technical experts and carried out on the machines if requested.

OIL HEATING UNIT.—A range of automatic oil-heating units suitable for heating bitumen kettles, heavy fuel oil bulk storage tanks, paddle mixers, &c., has been introduced by Frederick Parker, Ltd., Viaduct Works, Catherine Street, Leicester. Four models are available, the smallest being capable of heating 20,000 gallons of bitumen and the largest, 60,000 gallons. Known as the "Parker Hy-Way," the units consist of a non-pressure heat generator in which the oil, which is circulated through a closed circuit to heat dissipating coils, is heated and maintained at the desired temperature.

FLUOROCARBONS FROM COAL.—At the laboratories of the British Coal Utilisation Research Association, research has indicated the possibility of making stable transparent oils from coal at ordinary pressure in a single-stage process. This consists of reacting low-rank coal with gaseous chlorine trifluoride diluted with nitrogen to yield highly halogenated products, the chief of which is an oil having an approximate analysis of carbon 25 per cent, fluorine 65 per cent, and chlorine 7 per cent, and a wide boiling range, namely, 80 per cent, within 150 deg. to 350 deg. Cent. at atmospheric pressure.

INSTITUTION OF NAVAL ARCHITECTS.—The Spring Meeting of the Institution of Naval Architects will be held in London, March 24 to 26, and the annual general meeting will take place on the morning of Tuesday, March 24, followed by a paper entitled "Some Thoughts on Dry Docks," by T. Eustace Smith. Two papers will be presented on Wednesday morning, namely, "Train and Car Ferries," by J. P. Campbell, and "Container Ships," by D. A. Argyriadis, while in the afternoon the following papers will be read : "Re-Analysis of Ship Model Correlation—Data using the 1957 I.T.T.C. Line," by R. E. Clements, B.Sc., and "A Further Study of Ship Losses," by C. V. Manley. At the final session on the morning of Thursday, March 26, M. Yamagata, Dr.-Eng., will read his paper, "Standard of Stability Adopted in Japan," and L. Cristiani, Dr.-Ing., will present a paper entitled "Tonnage Measurement."

INSTITUTION OF LOCOMOTIVE ENGINEERS.—Nearly 700 members and guests attended the annual luncheon of the Institution of Locomotive Engineers, which was held in London on Friday, February 27 last. In proposing the toast of "The Institution," Sir David Eccles, the President of the Board of Trade, said that the modernisation plans of the British Transport Commission in introducing diesel and electric locomotive traction were of importance to the locomotive industry, in that both had an interest in the development of locomotives. The B.T.C. was interested in providing efficient and economical services, and in using the locomotives supplied by private industry it gave the manufacturers operational experience with new designs and provided them with facilities for showing their products to potential purchasers from overseas. On the subject of giving manufacturers credit to promote overseas sales, Sir David said that it was not to the ultimate interest to any country to indulge in a credit race. If, however, locomotive manufacturers could put forward a good case for extended terms of credit he would give it his full attention, but not otherwise. In replying to the toast the president of the Institution, Mr. R. Arbuthnott, pointed out the wide field of interest of the Institution which was shown by the fact that its *Proceedings* went to no less than sixty countries overseas. The B.T.C. had done much to assist makers in showing their products to potential buyers and helping on the training of new technicians for the locomotive industry. Prosperity of the railways, said Mr. Arbuthnott, was essential to the national well-being, and for this reason it was necessary that a better balance of freight carriage between the roads and rail should be arrived at in the near future.

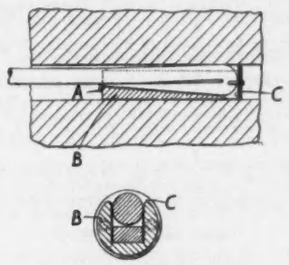
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

MINING ENGINEERING

808,509. February 1, 1956.—STRATA BOLTS, Hadfields Ltd., East Hecla Works, Sheffield, 9. (*Inventor : Harry Stevenson.*)

An example of a strata bolt in accordance with the invention is described with reference to the accompanying drawings. The bolt is made of a forged steel rod threaded at one end. On the rod is forged a



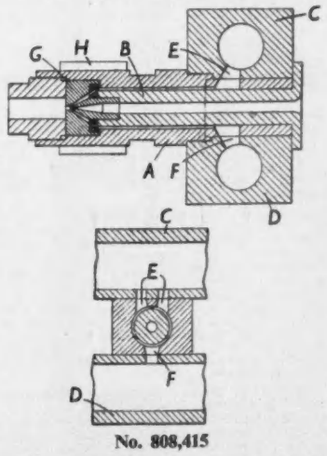
No. 808,509

tongue about 6in long, which tapers down to a rectangular section, the width across the two parallel opposite faces of which is the same as the rod diameter. This tongue is bent through 180 deg. so that one of its faces lies along the side of the rod. The head thus formed has a flat bounding surface on one side which slopes towards the axis of the bolt away from the head. The end of the tapering tongue is bent through a right angle to provide at the lower end of the head a projection or lug *A* about $\frac{1}{4}$in long. The wedge *B* of cast steel is approximately the same length as the head. It is in the form of a channel the internal section having a taper complementary to that of the head of the bolt. So that the bolt head will slide freely within the channel of the wedge when the holding nut is screwed up, the friction between the wedge and the hole is increased by attaching a friction pad in the form of a rubber disc *C* to the end of the wedge.—*February* 4, 1959.

EXTRUSION PLANT

808,415. May 20, 1954.—EXTRUSION APPARATUS, W. T. Henley's Telegraph Works Company, Ltd., 51-53, Hatton Garden, London, E.C.1, and Francis Tadman Griffiths, The Lodge, 1, Pine Avenue, Gravesend, Kent.

This invention relates to apparatus for extruding sheaths or coverings of metal such as lead or aluminium, or of plastic material, on to cables, rods, tubes, etc., which are passed through a mandrel and have an annular layer extruded on to the outside. In extrusion of this kind it is sometimes



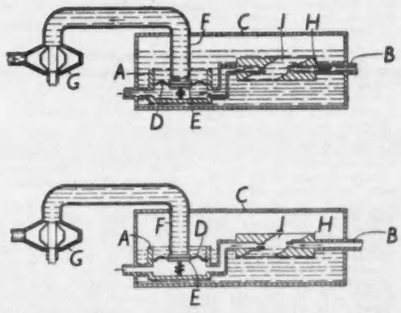
No. 808,415

found that the coverings show flow markings and the unrelieved stresses induced in the material during extrusion causes contraction of the sheath on the cable, especially when it is reheated for jointing or repairs. It is an object of the invention to overcome these drawbacks. Referring to the drawings, the die head illustrated is arranged for use in conjunction with two balanced screws so as to feed three colour streams from three delivery ports to provide a three-colour covering for a cable. It comprises an outer casing *A* within which lies a cylindrical mandrel *B* having a central bore for the passage of the cable to be covered. At the entry end of the casing there are shown diagramatically two casings, *C*, *D*, within which the balanced screws revolve. The upper screw delivers through two ports *E* while the lower screw delivers through a single port *F*. There are thus three delivery ports from the screws, while at the exit end of the casing there is the die proper. Between the casing and the mandrel is an annular passage extending between the delivery ports from the extruder and the die proper. This passage is divided along its entire length by three radial walls located at 120 deg. intervals so that the colour streams fed into the casing from the ports are extruded separately to produce the three-colour covering. The diameter of the mandrel is four to ten times the diameter of the finished covering and the reduction in diameter is brought about within the die *G* by a substantially conical passage. If desired, one or more heaters *H* may be located around the die assembly to maintain the temperature of the material at any required level during extrusion. It is believed that the behaviour of the extruded material is such that during its travel through the annular passage and preforming into the cylindrical sleeve, internal stresses are relieved considerably, if not entirely, and the relatively gradual further reduction through the conical passage in the die head does not set up further stresses to any great extent, since the material is suffering only a reduction in diameter of a shape already preformed. In addition, the colour streams are clean and sharply defined.—*February* 4, 1959.

MEASURING INSTRUMENTS

806,750. February 20, 1956.—DETECTING A FALL OF LEVEL OF A LIQUID IN A TANK, Joseph Lucas (Industries), Ltd., Great King Street, Birmingham, 19. (*Inventor : David Thomas Anthony Miller.*)

This device is required more particularly for actuating a valve for closing the inlet of a centrifugal or other pump, and thereby preventing air from entering a pump when the level of liquid in the tank



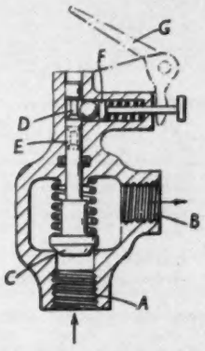
No. 806,750

which supplies the pump becomes exposed to air due to fall of the liquid level. One such use is in the fuel tanks of aircraft engines, where due to surging of the fuel in a tank or other cause, the entrance of the pump supply pipe which is normally immersed becomes exposed. The invention may, however, be applied to other uses, and may also be employed for actuating a signal or other means when the level of a liquid in a container falls below a given position. Referring to the drawing, the device comprises a shallow pressure chamber *A* having an inlet and outlet for connection to a pipe system *B* through which a liquid stream is continuously circulated by a pump, which may be a feed pump used on an aircraft for supplying fuel from a tank C to a prime mover. One side of the chamber is formed by a flexible diaphragm *D* which is movable by the pressure of the liquid flowing through the chamber *A* for actuating a valve *E* which serves to close the entrance of a pipe *F* leading to the prime mover. In the example illustrated the pipe *F* first supplies a supplementary centrifugal or boost pump *G* which in turn supplies the feed pump. Alternatively the diaphragm may serve to actuate a switch in the circuit of an electromagnetic means for actuating the valve. In communication with the entrance of the chamber is connected the pressure-modifier. This comprises a body *H* having a passage for the feed stream, which is intercepted by a transverse gap *J* which is open to the liquid in which the modifier is immersed. The arrangement is such that so long as the parts *A*, *H* remain wholly immersed the kinetic energy of the stream flowing across the gap *J* is sufficiently absorbed by its encounter with the liquid in the gap to reduce the pressure exerted by the stream on the diaphragm *D* to an ineffective amount as shown in the upper view. This effect is enhanced when the gap is inclined, as this results also in lateral deflection of the stream. But when the part *H* is exposed to the atmosphere of the tank due to change of level of the liquid as shown in the lower view, the energy of the stream entering the pressure chamber *A* is then sufficient to exert on the diaphragm the pressure required for actuating the associated valve so closing the entrance to the pipe *F*.—*December* 31, 1958.

HYDRAULIC ENGINEERING

808,577. March 27, 1956.—HYDRAULIC SAFETY VALVES, Rotol, Ltd., Cheltenham Road, Gloucester. (*Inventor : George Orloff.*)

This invention relates to hydraulic safety valves for high-pressure systems such as are installed in aircraft. An object of the invention is to provide a valve with a high lift characteristic, and in which the back pressure needed in the system to maintain the valve in the open position once it has lifted, is reduced. In the valve body is a chamber having a pressure-fluid inlet *A* at one end and an outlet *B* to exhaust through the side. The movable valve member *C* is spring-loaded on to a seat in the fluid inlet. A gland ring in the body provides a seal with the valve stem to prevent leakage, and beyond the gland ring the stem has a reduced diameter portion with chamfered end faces. This reduced portion *D* provides a



No. 808,577

recess in which, when the valve is closed, there is lodged a detent member in the form of a spring-loaded ball. The valve is thus held on its seat by the spring loaded ball detent lodged in the recess in its stem. After the initial opening of the valve, and once the ball detent has been dislodged, lifting of the valve continues against substantially only the valve spring pressure. If it is desired that once lifted the valve shall remain open until a reset control is operated, a further similar chamfered recess *E* is provided in the valve stem nearer to the valve head, so that the ball detent will automatically engage in this recess when the valve has lifted to its maximum. To provide a reset control, a plunger head *F* is interposed between the ball detent and its spring. By drawing out the plunger, the spring pressure on the ball is relieved, and this may be achieved by pivoting on the valve body a simple manual reset lever *G*. Alternatively, the reset control may be arranged for remote electrical operation.—*February* 4, 1959.

METALLURGY

807,531. January 31, 1956.—PRODUCTION OF CASTINGS, Patentverwertungsgesellschaft fur Eisen und Metalle mit beschrankter Haftung, Salzkotten, Westphalia, Germany.

The invention relates to a process for the production of castings, particularly of iron and iron alloys, including steels, but applicable also to non-ferrous melts, such as aluminium, containing impurities in the form of oxide slag inclusions capable of being reduced by hydrogen. It consists in introducing into the molten metal a measured quantity of hydrogen in the gaseous state, or as a substance such as a hydride that contains hydrogen, and continuing the introduction so long as the temperature of the molten metal continues to rise as the result of the introduction. The consumption of the hydrogen so introduced reduces the oxide slag inclusions, thus freeing the molten metal from such inclusions. The controlled introduction of hydrogen for the reduction of oxide slag inclusions brings about a deoxidation that achieves a refinement of the structure and renders it more compact. Reduction by hydrogen has the advantage of leading to products that escape from the molten metal in gaseous form. Methods of introducing hydrogen into a melt are described in some detail in the specification.—*January* 14, 1959.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, March 6.—BRISTOL AND WEST OF ENGLAND BRANCH : Grand Hotel, Bristol, Tape-Recording of A.S.E.E. Diploma Scheme Oral Examination, 8 p.m. ★ LIVERPOOL AND DISTRICT BRANCH : Industrial Development Centre, M.A.N.W.E.B., Paradise Street, Liverpool, 1, " Aspects of Electrical Installations and Modern Building Construction," 7.30 p.m. ★ STOKE AND CREWE BRANCH : Royal Hotel, Crewe, " A.C. Control Gear," S. H. Harding, 7.30 p.m.

Mon., March 9.—BOURNEMOUTH BRANCH : Grand Hotel, Firvale Road, Bournemouth, " Heat Pumps," J. A. Sumner, 8 p.m. ★ CENTRAL LONDON BRANCH : White Hall Hotel, Bloomsbury Square, London, W.C.1, " G.P.O. Submarine Cables," A. W. Welsh, 7.15 p.m. ★ NORTH WEST LONDON BRANCH : Century Hotel, Forty Avenue, Wembley Park, " Wartime Evasion and Escape," E. H. Maddox, 8.15 p.m.

Tues., March 10.—PORTSMOUTH AND DISTRICT BRANCH : Offices of the Ministry of Labour and National Service, Lake Road, Portsmouth, " Stage Lighting," F. P. Bentham, 7.30 p.m. ★ SOUTH EAST LONDON BRANCH : Eltham Green School, Queenscroft Road, Eltham, London, S.E.9, " Radio Frequency Heating," P. W. Ainscow, 7.45 p.m. ★ SOUTH WALES BRANCH: Angel Hotel, Cardiff, " High Fidelity Sound Reproduction," 7.30 p.m. ★ YORK BRANCH: " Georgian House," Blossom Street, York, " Variable Speed A.C. Motors," 7.30 p.m.

Wed., March 11.—BIRMINGHAM BRANCH : Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, " Rectifiers and their Applications," J. T. Whitehouse, 7.30 p.m. ★ BRADFORD BRANCH : Midland Hotel, Bradford, Film of the 1958 Electrical Engineers' (A.S.E.E.) Exhibition and Talk by E. A. Bromfield, 7.30 p.m. ★ GLASGOW BRANCH : Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2, " Group Motor Control Gear," D. A. Thomson, 8 p.m. ★ LUTON BRANCH : Luton Chamber of Commerce, George Street West, Luton, " Earthing," S. J. Emerson, 8 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., March 11.—SOUTH WALES SECTION : College of Advanced Technology, Cardiff, " Applications of Photo-Electric Cells," F. A. Benson, 6.30 p.m. ★ NORTH-EASTERN SECTION : Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne, " Microwave Strip-Line Circuits for Radar Equipment," K. Foster, 6 p.m. ★ WEST MIDLANDS SECTION : Wolverhampton and Staffordshire College of Technology, Wulfruna Street, Wolverhampton, " The Development of High Frequency Tape Recording," P. J. Guy, 7.15 p.m.

CHEMICAL SOCIETY

Thurs., March 12.—Burlington House, Piccadilly, London, W.1, Irving Langmuir Memorial Lecture, Sir Eric Rideal, 7.30 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., March 11.—NORTHERN REGION : Hotel Metropole, Leeds, " The Personnel Angle in Boiler House Efficiency," R. H. Thompson, 10.30 a.m. ★ SCOTTISH REGION : Grand Hotel, Charing Cross, Glasgow, C.3, " Reactor Engineering," J. W. Ashley, 10.30 a.m. ; " Firing of Heavy Fuel Oil," C. A. Roast, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., March 9.—SHEFFIELD CENTRE : Visit to Industrial Lighting Installation at Samuel Fox and Co., Stocksbridge Works, 6.30 p.m.

Thurs., March 12.—MANCHESTER CENTRE : North Western Electricity Board, Town Hall Extension, Manchester, 2, " Lighting in Commerce," K. C. White, 6 p.m.

Mon., March 16.—BATH AND BRISTOL CENTRE : Gardiner, Sons and Co., Ltd., Broad Plain, Bristol, " Airport Lighting," J. G. Holmes, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Tues., March 10.—EAST ANGLIAN CENTRE : Lecture Hall, Public Library, Ipswich, Competition Paper Evening for the L. J. Tibbenham Award, 7.30 p.m.

INSTITUTE OF FUEL

To-day, March 6.—S. WALES SECTION : S. Wales Electricity Board Showrooms, Kingsway, Swansea, " Gas Producers with special reference to S. Wales Coals," G. W. C. Allan, 6 p.m.

INSTITUTE OF MARINE ENGINEERS

Tues., March 10.—JUNIOR LECTURE : Borough Polytechnic, Borough Road, London, S.E.1, " Automatic Boiler Control," LL. Young, 6.45 p.m. ★ LONDON SECTION : Memorial Building, 76, Mark Lane, London, E.C.3, " Advances in Steam Turbines for Marine Propulsion," A. D. Somes, 5.30 p.m.

Mon., March 16.—WEST OF ENGLAND SECTION : Smith's Assembly Rooms, Bath, " The Application of Nuclear Power to Marine Propulsion," H. W. Bowker, 7.30 p.m.

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS

Mon., March 9.—NORTHERN CENTRE : North-Eastern Board's Lecture Theatre, Carliol House, Newcastle upon Tyne, Annual General Meeting, 6.45 p.m. ★ WESTERN CENTRE : Royal Agricultural College, Cirencester, " Problems of the Development Engineer," T. Sherwen, 7.15 p.m.

Tues., March 10.—LONDON CENTRE : 6, Buckingham Gate, London, S.W.1, " Cultivation of Sugar Cane and Rice," A. C. Howard, 2.15 p.m. ★ EAST MIDLANDS CENTRE : Odeon Ballroom, Angel Row, Nottingham, " Progress Report on Farm Safety," 7.30 p.m.

INSTITUTION OF CHEMICAL ENGINEERS

Tues, March 10.—NORTH WESTERN BRANCH : Chemical Engineering Building, College of Science and Technology, Jackson Street, Manchester, Whole-day Meeting, Symposium on Fluidisation.

INSTITUTION OF CIVIL ENGINEERS

Tues., March 10.—Great George Street, Westminster, London, S.W.1, " A Study of Bank-Full Discharges of Rivers in England and Wales," Marshall Nixon, 5.30 p.m.

Thurs., March 12.—MIDLANDS ASSOCIATION : James Watt Memorial Institute, Great Charles Street, Birmingham, 3, Talk by L. A. Rhodes, 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, March 6.—MEDICAL ELECTRONICS DISCUSSION GROUP : Savoy Place, London, W.C.2, Discussion on "Potted Histories of Instruments Designed for Medical Purposes," opened by H. S. Wolff, and " Co-ordination of Research in Medical Electronics," opened by R. G. Willison, 6 p.m. ★ N.E. CENTRE : Technical College, Carlisle, " The Deltic Locomotive," C. M. Cock, 7 p.m. ★ SHEFFIELD SUB-CENTRE : City Hall, Sheffield, " Automation," H. A. Thomas, 7.30 p.m.

Mon., March 9.—INFORMAL MEETING : Savoy Place, London, W.C.2, Discussion on " Need British Standards be Modified to Obtain Trade Abroad ? " opened by T. M. H. Stubbs, 5.30 p.m. ★ EAST ANGLIAN SUB-CENTRE : Electric House, Ipswich, " Recent Developments in Medium-Voltage H.B.C. Fuse Links," R. H. Dean, 7 p.m. ★ NORTH-EASTERN CENTRE : Neville Hall, Westgate Road, Newcastle upon Tyne, " The Design of Electro-Mechanical Auxiliaries Directly Associated with Power-Producing Reactors," A. E. Harwood, P. Scott and B. H. Stonehouse, 6.15 p.m. ★ SOUTH MIDLAND SUPPLY AND UTILIZATION GROUP: College of Technology, Birmingham, " The Design and Performance of the Gas-Filled Cable System," E. P. G. Thornton and D. H. Booth, 6 p.m. ★ WESTERN CENTRE : South Wales Institute of Engineers, Cardiff, " Results of Full-Scale Stability Tests on the British 132kV Grid System," F. Busemann and W. Casson ; " The Organisation for Large-Scale Grid System Tests," F. H. Last, E. Mills and N. D. Norris 6 p.m.

Tues., March 10.—EDUCATION DISCUSSION CIRCLE : Savoy Place, London, W.C.2, Discussion on " The Laplace Transform—A Tool for the Electrical Engineer," opened by A. C. Sim, 6 p.m. LONDON GRADUATE AND STUDENT SECTION : Technical College, Reading, Berks, " Stereophonic Sound," E. W. Berth-Jones, 7 p.m. ★ NORTHERN IRELAND CENTRE : David Keir Building, Queen's University, Stranmillis Road, Belfast, " The B.B.C. Sound Broadcasting Service on Very-High Frequencies," E. W. Hayes and N. Page, 6.30 p.m.

Wed., March 11.—LONDON GRADUATE AND STUDENT SECTION : Visit to Post Office Research Station, Dollis Hill, London, N.W.2, 2.15 p.m. ★ NORTH LANCASHIRE SUB-CENTRE : North-Western Electricity Board Demonstration Theatre, Friargate, Preston, " Computers," R. L. Grimsdale, 7.15 p.m. ★ SOUTH-WEST SCOTLAND SUB-CENTRE : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, C.2, " Electrical Installation at Calder Hall Nuclear Power Station," N. J. Mackay and E. Hardwick, 7 p.m. ★ RUGBY SUB-CENTRE : College of Technology and Arts, Rugby, " Generator/Motor Problems in Pump Storage Installations," J. H. Walker ; Annual General Meeting, 6.30 p.m. ★ SOUTHERN CENTRE : Technical College, Brighton, " Generation of Electricity in the London Area," H. V. Pugh, 6.30 p.m. OXFORD DISTRICT BRANCH : Demonstration Room, Southern Electricity Board, 37, George Street, Oxford, " Zeta," R. Carruthers, 7 p.m.

Thurs., March 12.—UTILIZATION SECTION: Savoy Place, London, W.C.2, Joint Meeting with the London Graduate and Student Section, " Coal Mining and Electricity," A. P. Foster ; " Electric Drives in the Paper Industry," P. D. House ; " Standardisation and Simplification of Switchgear," M. J. L. Willison, 5.30 p.m. ★ SOUTH-WESTERN SUB-CENTRE: S.W.E.B. Showrooms, Bedford Street, Exeter, " Germanium and Silicon Power Rectifiers," T. H. Kinman, G. A. Carrick, R. G. Hibberd and A. J. Blundell, 3 p.m. ★ WEST WALES (SWANSEA) SUB-CENTRE : Conference Room, S.W.E.B. Showrooms, The Kingsway, Swansea, " Electric Control of Stage and Television Lighting," F. P. Bentham, 6 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Mon., March 9.—NORTH-EAST BRANCH : Northern Architectural Association Hall, 6, Higham Place, Newcastle upon Tyne, 1, " The Development of Calder Hall," H. Cullen, 7.15 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

To-day, March 6.—Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, " Oxford Eastern By-Pass," K. Summerfield, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, March 6.—ORDINARY MEETING IN CONJUNCTION WITH THE STEAM GROUP : 1, Birdcage Walk, Westminster, London, S.W.1, " Approximate Equations for the Properties of Superheated Steam," J. H. Horlock, 6 p.m. ★ WESTERN BRANCH : Cornwall Technical College, Camborne, Chairman's Address, 7.15 p.m.

Mon., March 9.—BIRMINGHAM A.D. CENTRE : James Watt Memorial Institute, Great Charles Street, Birmingham, " Some Aspects of the Work of the Road Research Laboratory," H. J. Starks, 6.45 p.m.

Tues., March 10.—SOUTH WALES BRANCH : Angel Hotel, Abergavenny, " Design by Analogy," J. O'N. Fisher, and E. Wilson, 6 p.m.

Wed., March 11.—EAST MIDLANDS BRANCH : Rolls-Royce Welfare Hall, Derby, Joint Meeting with the East Midlands Graduates' Section, " An Experimental Pressure Exchange Engine and its Future Possibilities," R. D. Pearson, 6.30 p.m.

Thurs., March 12.—NORTH WESTERN INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP : Engineers' Club, Albert Square, Manchester, " Powder Metallurgy Applications," 6.45 p.m. ★ YORKSHIRE BRANCH : The University, Leeds, Repetition of the James Clayton Lecture, " Large Pipeline Projects," A. C. Hartley, 6.30 p.m. ★ WESTERN GRADUATES' SECTION : Pump Room, Bath, Engineers' Brains Trust, 7.15 p.m.

Fri., March 13.—WESTERN BRANCH : Technical College, Gloucester, " Numbers, Statistics and Computers in the Engineering Industry," H. McGregor Ross, 7.30 p.m.

Sat., March 14.—YORKSHIRE GRADUATES' SECTION : Visit to Cravens, Ltd., Darnall, 10 a.m.

INSTITUTION OF PLANT ENGINEERS

Tues., March 10.—MANCHESTER BRANCH : Engineers' Club, Albert Square, Manchester, Annual General Meeting, 7.15 p.m.

Wed., March 11.—DUNDEE BRANCH : Taypark Hotel, West Ferry, Dundee, Annual General Meeting, 7.30 p.m. ★ EAST MIDLANDS BRANCH: Sherwood Room, County Hotel, Theatre Square, Nottingham, Annual General Meeting, 7 p.m. ★ EDINBURGH BRANCH : 25, Charlotte Square, Edinburgh, Annual General Meeting, " Factory Drainage," T. W. Prentice, 6.45 p.m.

Thurs., March 12.—GLASGOW BRANCH : More's Hotel, India Street, Glasgow, Annual General Meeting, 7.15 p.m. ★ NORTH EAST BRANCH : Roadway House, Oxford Street, Newcastle upon Tyne, Annual General Meeting, 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., March 9.—NORTH WESTERN REGION : Grand Hotel, Hanley, Stoke-on-Trent, Annual General Meeting ; " Modern Welding Processes," H. Roberts, 7 p.m. ★ SOUTH WESTERN REGION : North Gloucestershire Technical College, The Woodlands, The Park, Cheltenham, " The Russian Approach and Background to Machine Tool Production," Norman Stubbs, 7 p.m.

Tues., March 10.—EAST AND WEST RIDINGS REGION : Technical College Hall, Doncaster, Annual General Meeting, 7 p.m. ★ BIRMINGHAM GRADUATE SECTION : James Watt Memorial Institute, Great Charles Street, Birmingham, Annual General Meeting, 7 p.m. Chairman's Address, " Interesting Setups in Heavy Axle Production," D. J. White, 7.30 p.m. ★ LONDON GRADUATE SECTION : Full-day visit to J. Stone and Co. (Charlton), Ltd., Woolwich Road, Charlton, London, S.E.7. ★ SOUTH-EASTERN REGION : Small Assembly Room, Town Hall, Luton, Annual General Meeting, 7.30 p.m. ★ SOUTHERN REGION : Town Hall, Oxford, " Financial Aspect of General Theme," 7.30 p.m.

Wed., March 11.—1958 VISCOUNT NUFFIELD PAPER : Lecture Theatre, Department of Mechanical Engineering, The University, Birmingham, " The Production, Fabrication, Properties and Uses of Some of the Newer Metals," N. P. Inglis, 6.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, March 6.—LANCASHIRE AND CHESHIRE BRANCH : College of Building, Clarence Street, Liverpool, " Design of Reinforced Concrete Sections with special regard to C.P.114, 1957," C. E. Reynolds, 6.30 p.m. ★ W. COUNTIES BRANCH : University Engineering Laboratories, Bristol, " Suspension Bridges To-day," Sir Alfred Pugsley, 6 p.m.

Tues., March 10.—SCOTTISH BRANCH : Institution of Engineers and Shipbuilders, Glasgow, " A Survey of Recent Concrete Work in Scotland," E. H. Cooley, 7 p.m.

Wed., March 11.—YORKSHIRE BRANCH : Electricity Building, Ferensway, Hull, " The Garry and Moriston Hydro-Electric Schemes," C. M. Roberts, E. B. Wilson, J. H. Thornton and H. Headland, 6.15 p.m.

Thurs., March 12.—11, Upper Belgrave Street, London, S.W.1, " Berkeley Power Station, with Particular Reference to the Design of the Reactor Buildings," D. R. R. Dick, 6 p.m.

Fri., March 13.—MIDLAND COUNTIES BRANCH (GRADUATES' AND STUDENTS' SECTION) : Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham, " Light Alloys in Structural Work," R. M. Davies, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, March 6.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, Film Evening, 7 p.m.

Mon., March 9.—SHEFFIELD SECTION : Livesey Clegg House, 44, Union Street, Sheffield, 1, " Paper Making Machines," 7.30 p.m.

Fri., March 13.—Pepys House, 14, Rochester Row, Westminster, London, S.W.1, " Ninety Million Gallons Per Day," 7 p.m.

LIVERPOOL METALLURGICAL SOCIETY

Thurs., March 12.—Library, Department of Metallurgy, The University, 146, Brownlow Hill, Liverpool, 3, " The Rare Metals Used in Atomic Energy Applications," L. R. Williams, 7 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY

Thurs., March 12.—Wigan and District Mining and Technical College, Wigan, " Progressive Development of Mining Machinery Through Usage Underground," A. Yorke Saville, 3.15 p.m.

NEWCOMEN SOCIETY

Wed., March 11.—Lecture Theatre, Science Museum, South Kensington, London, S.W.7, " The Coalbrookdale Group Horsehay Works," R. A. Mott, 5.30 p.m.

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Mon., March 9.—Lecture Theatre, Mining Institute, Newcastle upon Tyne, " Optical Marking and Automatic Plate Production," W. R. Mellanby, 6.15 p.m.

PLASTICS INSTITUTE

Thurs., March 12.—TENTH ANNUAL LECTURE : Wellcome Foundation Building, Euston Road, London, N.W.1, " International Competition in the Chemical Industry," S. P. Chambers, 6.30 p.m.

ROYAL INSTITUTION OF CHARTERED SURVEYORS

Thurs., March 12.—12, Great George Street, Westminster, London, S.W.1, " Hillshading for Relief Depiction in Topographical Maps," L. J. Harris, 5.45 p.m.

ROYAL STATISTICAL SOCIETY

Tues., March 10.—MERSEYSIDE GROUP : Royal Institute, Colquitt Street, Liverpool, " Non-Linear Regression Analysis," R. L. Plackett, 7 p.m. ★ GLASGOW GROUP : Royal College of Science and Technology, Glasgow, " Statistical Testing Without Tables," W. E. Duckworth, 7.30 p.m.

Wed., March 11.—GENERAL APPLICATIONS SECTION : Royal Institute of Public Health and Hygiene, 28, Portland Place, London, W.1, " Industrial Market Research," L. A. Williams, 6.15 p.m. ★ EDINBURGH GROUP : Chamber of Commerce, 25, Charlotte Square, Edinburgh, " The Efficiency of Machines Subject to Regular Servicing," A. J. Howie, 7.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., March 10.—CHELTENHAM SECTION : Rotunda, Cheltenham, " Instrumentation on the Trans-Antarctic Expedition," 7.30 p.m. ★ MANCHESTER SECTION : " Manchester Room," Central Library, St. Peters Square, Manchester, 1, " Electro-Magnetic Flow Meters," L. M. Bennett, 6.30 p.m.

Fri., March 13.—MIDLAND SECTION : Regent House, St. Philip's Place, Colmore Row, Birmingham, 3, " Valves, Electrically and Pneumatically Operated," L. B. Rothwell, 7 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Fri., March 13.—39, Elmbank Crescent, Glasgow, Joint Meeting with the Iron and Steel Institute, Engineers' Group, " The Installation and Commissioning of an 80-ton Electric Arc Melting Furnace," P. M. Thomas and A. MacNaughton, 6.45 p.m.

Advanced Engineering Courses

Management Appreciation Course in Work Study. LOUGHBOROUGH COLLEGE OF TECHNOLOGY, LOUGHBOROUGH, LEICESTERSHIRE. Two-day course in work study, Wednesday and Thursday, Arpil 22 and 23. Applications for reservations should be sent to James France, M.I.Mech.E., Head of Department of Industrial Engineering. Fees, tuition £5, residence £3.

International Course in Hydraulic Engineering. THE NETHERLANDS UNIVERSITIES FOUNDATION FOR INTERNATOOAL CO-OPERATION, Molenstraat 27, The Hague, The Netherlands. Three programmes have been compiled from the subjects given in the course. They are : (*a*) Tidal and Coastal Engineering (including harbours) ; (*b*) Reclamation ; (*c*) Rivers and Navigation Works (including ground water recovery). The course is open to those who have received a thorough preliminary training in engineering. It will begin on October 21, 1959, with registration and the introductory period ; the actual instruction commencing on October 27. The course will terminate on September 8, 1960. The tuition fee is 1200 Dutch guilders.

Basic Principles of Nuclear Engineering. DEPARTMENT OF EXTRA-MURAL STUDIES, University of Liverpool, 9, Abercromby Square, Liverpool, 7. A short introductory course, April 12 to 18, intended primarily for qualified engineers and others who wish to acquire some understanding of the problems of large-scale nuclear power programmes. Fee £21 (non-residential students £15).

Arc and Glow Discharges. DEPARTMENT OF EXTRA-MURAL STUDIES, University of Liverpool, 9, Abercromby Square, Liverpool, 7. Course of twelve lectures, April 12 to 17, covering elementary gas kinetic theory, collision processes and gas swarm phenomena, energy distribution and discharge temperatures, gas conduction theory, plasma equations and properties, plasma energy balance, anode and cathode properties, and low and high pressure glow and arc discharges, special arc types and arc stabilisation, the recovery of arcs and circuit interruption. Fee £15 15s. (non-resident student £10 10s.).

MATERIAL HANDLING EQUIPMENT Standard

or to your own specification

BENCHES
SPECIAL PURPOSE BOGIES
FLAT PALLETS
SWARF REMOVAL TRUCKS
TUBE OR BAR STORAGE RACKS
FOUR-WAY ENTRY ALL STEEL PALLETS
GRAVITY ROLLER CONVEYORS
TEXTILE BOGIES
MOBILE STILLAGES
THE "TUDOR" TOOL CABINETS
INDUSTRIAL TRAILERS
HAND OR TRAILER DRAWN INDUSTRIAL TRAILERS
HEAVY DUTY STACKABLE PALLETS
BRICK & TILECURING PALLETS

All Steel Factory Equipment saves Time, Space, Money.

★ *ALSO GENERAL FABRICATION WORK.*
ENQUIRIES INVITED

JOHN S. YOUNG & CO., LTD.
MARYVILLE AVENUE, GIFFNOCK, GLASGOW.
Telephone: Giffnock 1101 (6 lines) Telegrams: 'Stedmacs Giffnock Glasgow.'

PLEASE WRITE FOR THIS CATALOGUE

LEDWARD & BECKETT LTD.
PARLIAMENT MANSIONS ABBEY ORCHARD ST.
LONDON S.W.1
PHONE: ABBEY 5429 TELEGRAMS: PREFERMENT, SOWEST-LONDON

GENUINE PS STUBS SILVER STEEL

★ The best known brand in the world and the standard to which all other makers endeavour to work.

★ Accurate to .00025" for all sizes up to 1" diameter.

★ Supreme surface finish—a heritage of craftsmanship.

★ Made in 252 standard sizes—a size or every job to save machining costs.

GENUINE PS STUBS FILES also have the same heritage of craftsmanship behind them as **GENUINE PS STUBS SILVER STEEL.**

Insist on these quality goods by specifying **GENUINE PS STUBS.**

PETER STUBS LIMITED
WARRINGTON · ENGLAND
FOUNDED IN 1773

S526

AUTOMETRIC
pumps
for

many
purposes

CENTRIFUGAL
GEAR
TURBINE - SINGLE & MULTI-STAGE
•MINI-GEAR
HAND ROTARY
OSCILLATING PISTON
ROLLER VANE
VACUUM
•DIAPHRAGM VACUUM
• H.P. 230 I 50 MOTORISED

write for catalogue

AUTOMETRIC PUMPS LTD
LOWER WATERSIDE
MAIDSTONE · KENT
PHONE: MAIDSTONE 4728

IN CASE OF FIRE

CUT OFF THE OIL SUPPLY TO YOUR BOILER HOUSE QUICKLY

WITH THE NABIC QUICK RELEASE FITTING

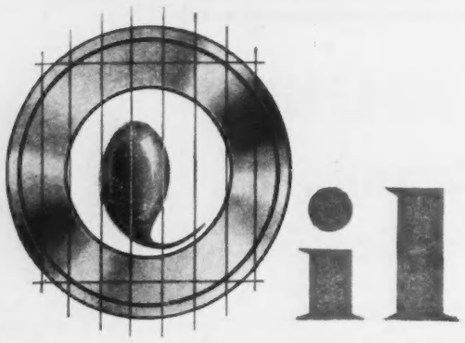
For use with oil firing equipment, dampers and fire screens etc.

Full details from:—
THE NATIONAL BOILER & GENERAL INSURANCE CO. LTD.
Sales Department, ST. MARY'S PARSONAGE, MANCHESTER, 3.

WILLIAM
GEIPEL
LIMITED

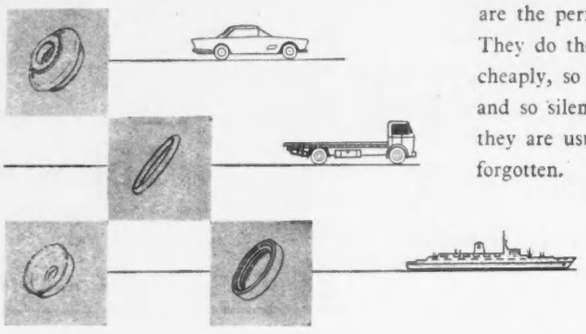
ELECTRIC CABLES
ELECTRIC CONTROL GEAR
STEAM TRAPS

VULCAN WORKS,
156-170 BERMONDSEY ST.,
LONDON, S.E.1.



is a difficult prisoner...

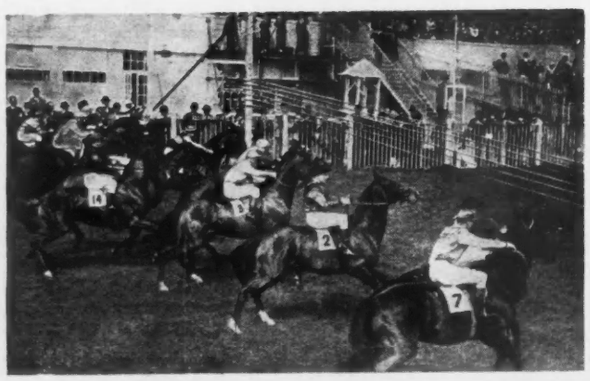
and it must be kept in solitary confinement too; no fraternisation with that insidious enemy dirt, either. SuPerfect Oil Seals are the perfect goalers. They do their job so cheaply, so efficiently, and so silently that they are usually completely forgotten.



SUPERFECT

SUPER OIL SEALS & GASKETS LTD.
FACTORY CENTRE, BIRMINGHAM, 30.

Manufacturers of 'SuPerfect' Hydraulic Packings and 'O' Rings; 'Romet' water pump seals and mechanical pump seals; 'Aeroquip' Flexible Hose with detachable re-usable fittings; 'Fidrac' mechanical rubber mouldings; 'Redcaps' Polythene Protective Caps and Plugs.

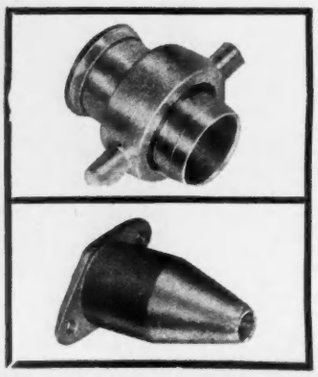


May we pick the winner for you . . .

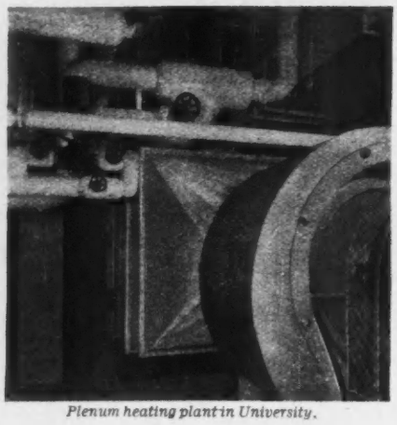
When choosing between Die Castings or Hot Pressings you can count on us for sound, unbiased advice! We make both HOT PRESSINGS in *Brass, Bronze, Copper or Aluminium* and GRAVITY DIE CASTINGS in *Brass, Bronze or Aluminium.* The unique experience of our organisation . . . two separate yet inter-related operations under one roof . . . will ensure that your choice is correct. For a constant or phased supply of DIMENSIONALLY ACCURATE PARTS in *Brass, Bronze, Copper or Aluminium*—see us first! Our Technical Representatives are always at your service.

BRASS PRESSINGS (LONDON) LTD.
THE NON-FERROUS DIE CASTING CO. LTD.
Non-Ferdica Works, North Circular Road London N.W.2 Tel: GLAdstone 6377 1732A

The choice is often difficult



Electrical insulation
in mechanical service
visit stand K15
and talk
TUFNOL
(REGISTERED TRADE MARK)
The Electrical Engineers' Exhibition
EARLS COURT March 17-21
TUFNOL LTD · PERRY BARR · BIRMINGHAM 22B
Does not chip
Punches readily to shape
373



Plenum heating plant in University.

profit by experience . . .

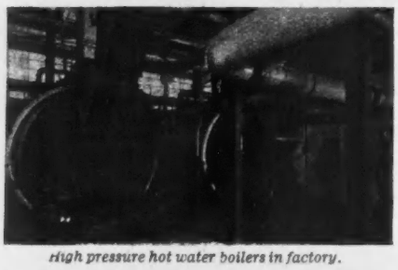
SPACE HEATING
IN EVERY FORM
DOMESTIC & INDUSTRIAL
HOT AND COLD WATER
SYSTEMS
AIR CONDITIONING
AND VENTILATION
DUST AND FUME REMOVAL
STEAM PLANT AND
PIPELINE INSTALLATION

Whatever the problem—S.E.I. are best qualified to design, engineer and install the perfect system evolved to meet each specific need. The cumulative experience of 80 years' research and practice is immediately available. Specialists in the latest methods of invisible Heating and the new Radiant system for use with acoustic and suspended ceilings. Advanced techniques in the suppression of air pollution at source offer a vital service to industry.

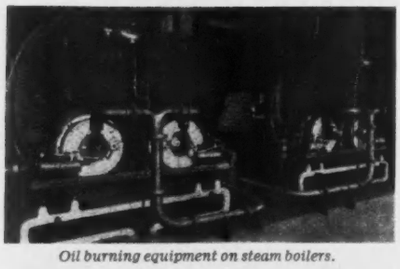
Control panel and gas-fired boiler in departmental store.

SEI
STEELS ENGINEERING INSTALLATIONS

experience



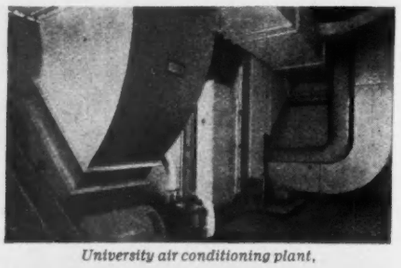
High pressure hot water boilers in factory.



Oil burning equipment on steam boilers.

Hot water service shower ranges.

Embedded floor heating panels.



University air conditioning plant.

STEELS ENGINEERING INSTALLATIONS LIMITED
Head Office: Crown Works, Sunderland

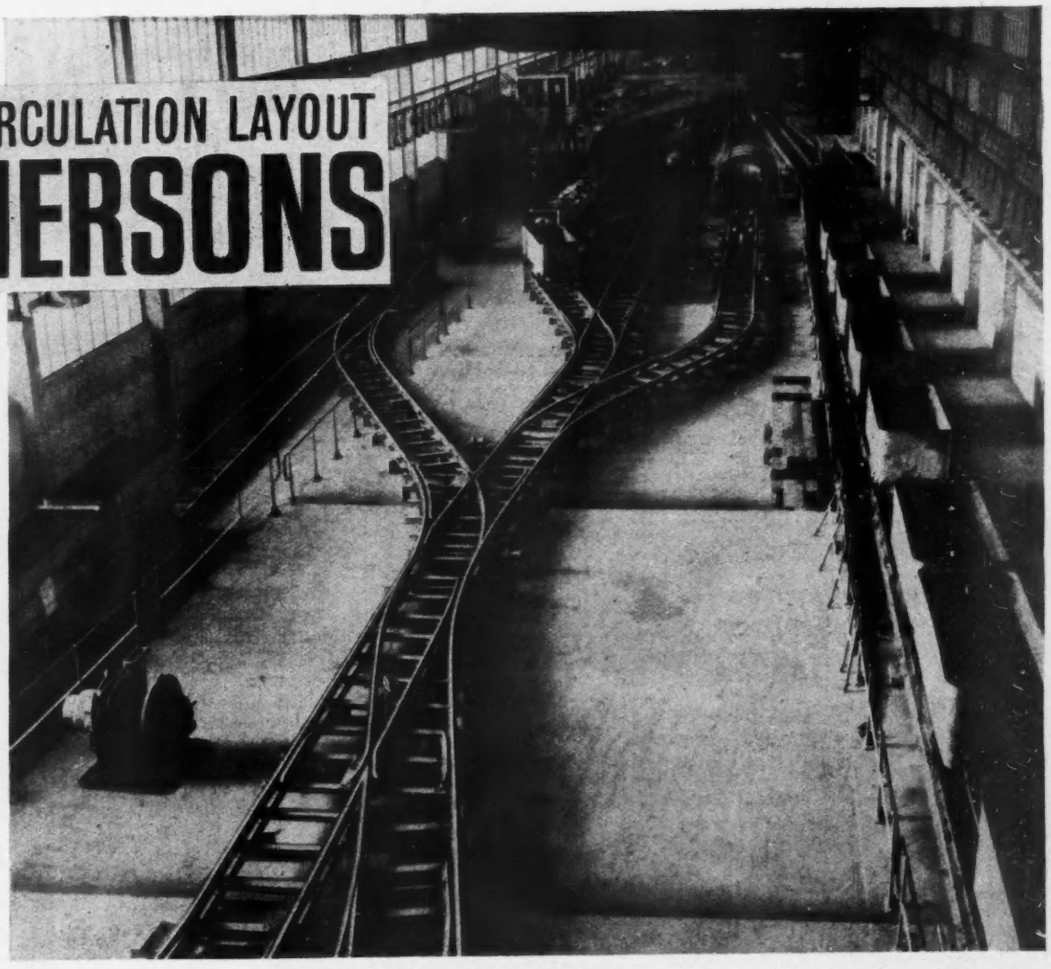
LONDON: 143 Sloane St., S.W.1. BIRMINGHAM: 172 St. Paul's Rd., Balsall Heath, 12. NEWCASTLE-ON-TYNE: 13 Brunswick Place, 1.

Scottish Associates SEI (Scotland) Ltd., GLASGOW: 529 Sauchiehall St., C.3.

STEEL

216

N.C.B. MINE CAR CIRCULATION LAYOUT By SUMMERSONS

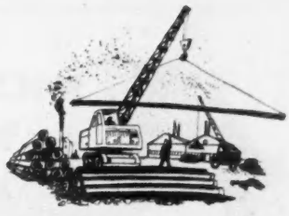


This indoor Mine Car layout at a Scottish Colliery is an example of the versatility of Summersons designing and manufacturing resources. Laid on a stepped concrete floor, the 3ft. oin. gauge 50 lb. F.B. Rail Tracks are fastened to transverse steel channel sleepers bolted to longitudinal steel joists or plate girders, by which means the appropriate gradients are obtained. Cars are gravity operated and the switches electrically controlled from a central panel.

Main Contractors : Markham & Co., Ltd., Chesterfield.

THOS. SUMMERSON & SONS LTD.
Mowden Hall, Darlington.
Telephone Darlington 5226
London Office : 5a Deans Yard, S.W.1.
Telephone ABBey 1365

POWER for industry



Our range of industrial engines are a practical proposition for many types of industrial equipment . . . **compressors, cranes, pumps, contracting equipment, earth borers, generators, railcars, welding plant, works trucks, tractors and conversions.** Simple design, modern flow-line production methods and common interchangeable parts contribute to the low cost of these high efficiency engines. And remember, every engine is fully backed by a World-wide Parts and Service Organisation. Take your choice from a wide power range . . . Diesel 20 to 86 b.h.p. and Petrol 11 to 87 b.h.p. (12-hr. rating).

DIESEL ECONOMY—have you considered the replacement of existing power units in your equipment and trucks with the famous 4D Diesel engine? You'll have the unique advantages of economy, long-life and low running costs . . . plus the best service in the World!

Wherever you are, whatever your problem,

FORD

MOTOR COMPANY LIMITED ENGLAND

are at your service

For further details of our

INDUSTRIAL ENGINES

and the equipment they power, send the coupon to your nearest Ford Dealer or direct to

Please send me technical brochures of your *PETROL/DIESEL Industrial Engines. The maximum B.H.P. required is ..... at ..... R.P.M. Also, please send details of the following equipment powered by your engines.

.....

.....

Name .....

Address .....

.....

Nature of Business .....

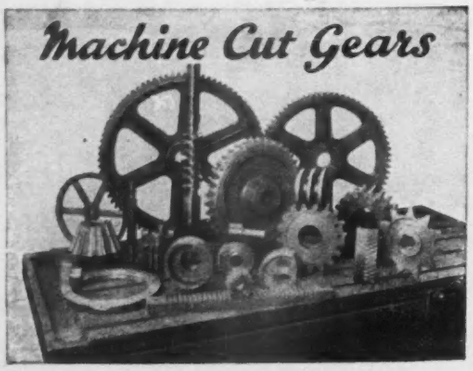
..... **Telephone No.** .....

* *Delete where not applicable* G51-22-3

FORD MOTOR COMPANY LTD · PARTS DIVISION (G51) · AVELEY DEPOT · SOUTH OCKENDON · ROMFORD · ESSEX · ENGLAND

SPURS
BEVELS
WORM WHEELS
HELICALS
CHAIN GEARS
Complete Supply
Cutting Only

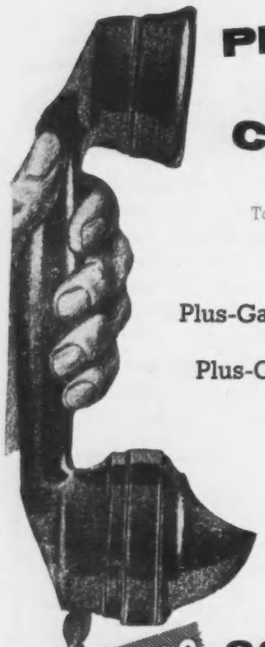
Machine Cut Gears



WORMS
RACKS
SCREWS
SILENT GEARS
CHANGE GEARS
All materials standard pitches to 7ft diameter

General machine castings made to customers' patterns. Low prices for planing, boring, turning, screwcutting
Send your enquiries to
GREENWOOD'S STANDARD GEAR CUTTING CO. LTD.,
New Bond Street, Halifax. *Telephone: Halifax 5217/8* *Telegrams: "Gears."*

PRECISION—ENGLAND
Chains of Quality
STEEL CONVEYOR CHAIN
CRANKED LINK ROLLER CHAIN for Civil Engineering Plant
BIPLANER CHAINS for Overhead Conveyors
MALLEABLE REPLACEMENT CHAIN (2.609 P.)
PRECISION CHAINS LTD.
MARSDEN WORKS, CLAYTON LANE, MANCHESTER 11, Telephone: EASt 3421
PRECISION



PICK THIS UP TO STOP CORROSION!

To solve your corrosion problems, get in touch with Plus-Gas the Anti-Corrosion Specialists: their Technical Advisory Service covers the whole country.
Plus-Gas Formula 'A' Dismantling Fluid, (Rust Remover).
Plus-Gas Formula 'B' Protective Fluid. Used and approved by all industries for many years.
Have you heard of
Plus-Gas Formula 'E'
External Metal Treatment (Tannating Primer)?

The Engineering, Marine Welding and Nuclear Energy Exhibition
Stand No. 1, Row AA, 1st Floor
Empire Hall

PLUS-GAS COMPANY LTD
1/11 Hay Hill
London W1
Tel: HYDe Park 9566/9

CUTTING COSTS IN INDUSTRY

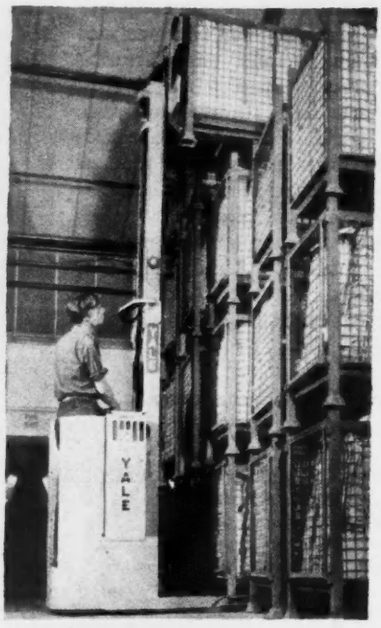
Vital storage space saved, production delays ended, with versatile Yale trucks

IN PRINTING . . .

Storage of a weekly intake of 75 tons of paper and board is no problem at Taylowe Ltd. Three Yale trucks speed handling and ensure maximum use of storage space in warehouse and production areas. This Yale Warehouser, working in aisles only 6 feet wide, and stacking pallets 13′ 6″ high, helps maintain strict inventory control over all stocks.

Yale Warehousers are available in Platform models (2 tons); Fork Lift models (2,000 and 3,000 lbs).

The Yale range includes power trucks for every need up to 200,000 lbs; Hand Trucks for loads up to 12,000 lbs; Hoists for lifting up to 40 tons (trolleys for all models); Pul-Lifts (from ½ to 15 tons).



IN DISTRIBUTIVE TRADES...

Warehouse capacity increased by 15%, labour force reduced by 18% and released for more productive work. These are among the striking economies achieved by Galbraith's chain grocery stores since installing a fleet of 31 Yale trucks of various types. Over 900 different 'lines' are supplied to 200 shops from Galbraith's Scottish warehouse. The Series 51 truck, shown here stacking palletised barrels of butter, has helped to speed handling and cut storage costs by working in narrow aisles and stacking 14 feet high. Quantity of goods handled in an hour has risen by over 30%.

Yale Series 51 electric trucks are available in capacities from 3,000 lbs. to 10,000 lbs.

IN FOUNDRIES . . .

Production delays are minimised by Yale trucks in the Leeds foundry of Catton & Company Limited. In Fettling Shop and Despatch Department, movement by electric platform Worksaver saves time and ensures most productive use of labour. The truck seen here with castings being segregated in the Despatch Department is so simple to use, no special truck operator is required.

Yale Worksavers are available in Platform or Pallet models (2 or 3 tons); Fork Lift (1,500, 2,000, 2,500, 3,000 lbs); Tractor (700 lbs. draw-bar pull).

YALE
REGISTERED TRADE MARK

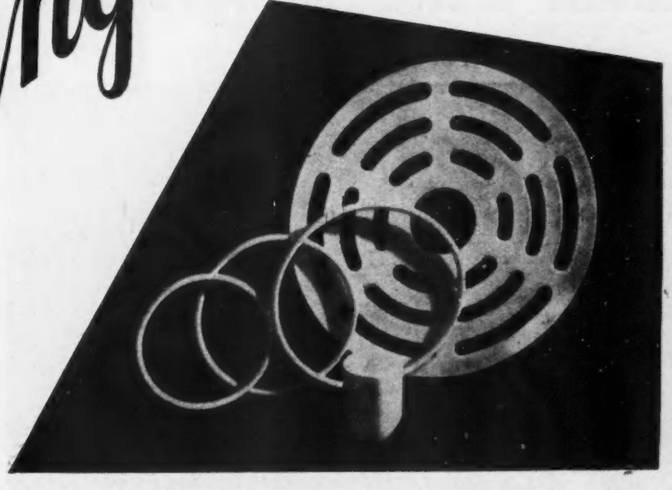
The world's largest range of materials handling equipment

YALE ADVISORY SERVICE *For free advice on your own handling problem, write to the address below*

THE YALE & TOWNE Manufacturing Company · Materials Handling Division
Department E3 · Wednesfield · Staffordshire · Telephone: Willenhall 941

Richard Klinger Limited are specialists in the production of articles in P.T.F.E. (Polytetrafluorœthylene) which is a material universally sold under such trade names as "Fluon", "Teflon", and "Algaflon".

Klingerflon



The material processed at Klingerit Works, Sidcup, is "Fluon" which is the trade name for the P.T.F.E. manufactured in Great Britain by Imperial Chemical Industries Ltd.
Included in the list of articles sold by Richard Klinger Ltd. under their trade mark "KLINGERFLON", are O-rings and Chevron type packing rings, as illustrated.

RICHARD KLINGER LIMITED

KLINGERIT WORKS · SIDCUP · KENT *Tel: Foots Cray 7777*

C16/58/P

DANKS OF NETHERTON LTD.

Over a century of boiler making and engineering experience have gone into the manufacture of Danks patented SUPAPAK package boiler.

Principal advantages:

★ Treblepass Danks patented "Interflo" design boiler.

★ Fully automatic.

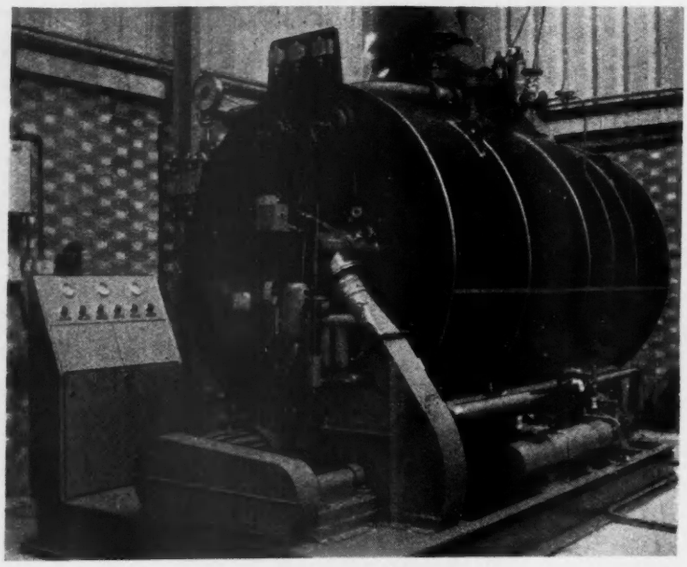
★ Accessibility top and bottom.

★ Over 80% efficiency.

★ CO_2 13½% to 14% over entire modulating range.

★ All welded construction up to 250 p.s.i.

Patent No. 736020.



Brochure on application to

DANKS OF NETHERTON LTD.

Netherton, Dudley, Worcs.
Tel.: Cradley Heath 66417

London Office - Bank Chambers - High Holborn - W.C.1. - Holborn 2065

ARMOURCHROME

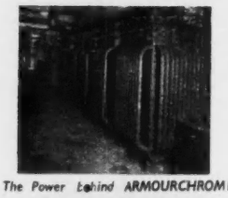
The PROVEN process for Hard Chromium Deposition

Armourchromed Rolls, over 11ft long, in use at Banbury.
Photograph by courtesy of The Northern Aluminium Co. Ltd.

ARMOURCHROME will increase the working life of Rolls, Die-Sets and Press Tools several times. Be sure your NEW equipment is pre-treated with this cost-cutting, ultra-durable process and remember that worn, rejected components can be reclaimed by the application of ARMOURCHROME. Approved by A.I.D. Test House and the various Ministries, ARMOURCHROME provides a VDH rating of approximately 900, helps to eliminate scoring, roll marks and other blemishes from the finished job besides giving protection from deterioration in storage. Ask our Technical Sales Department for further details NOW!

Scientific Control

Skilled Technique

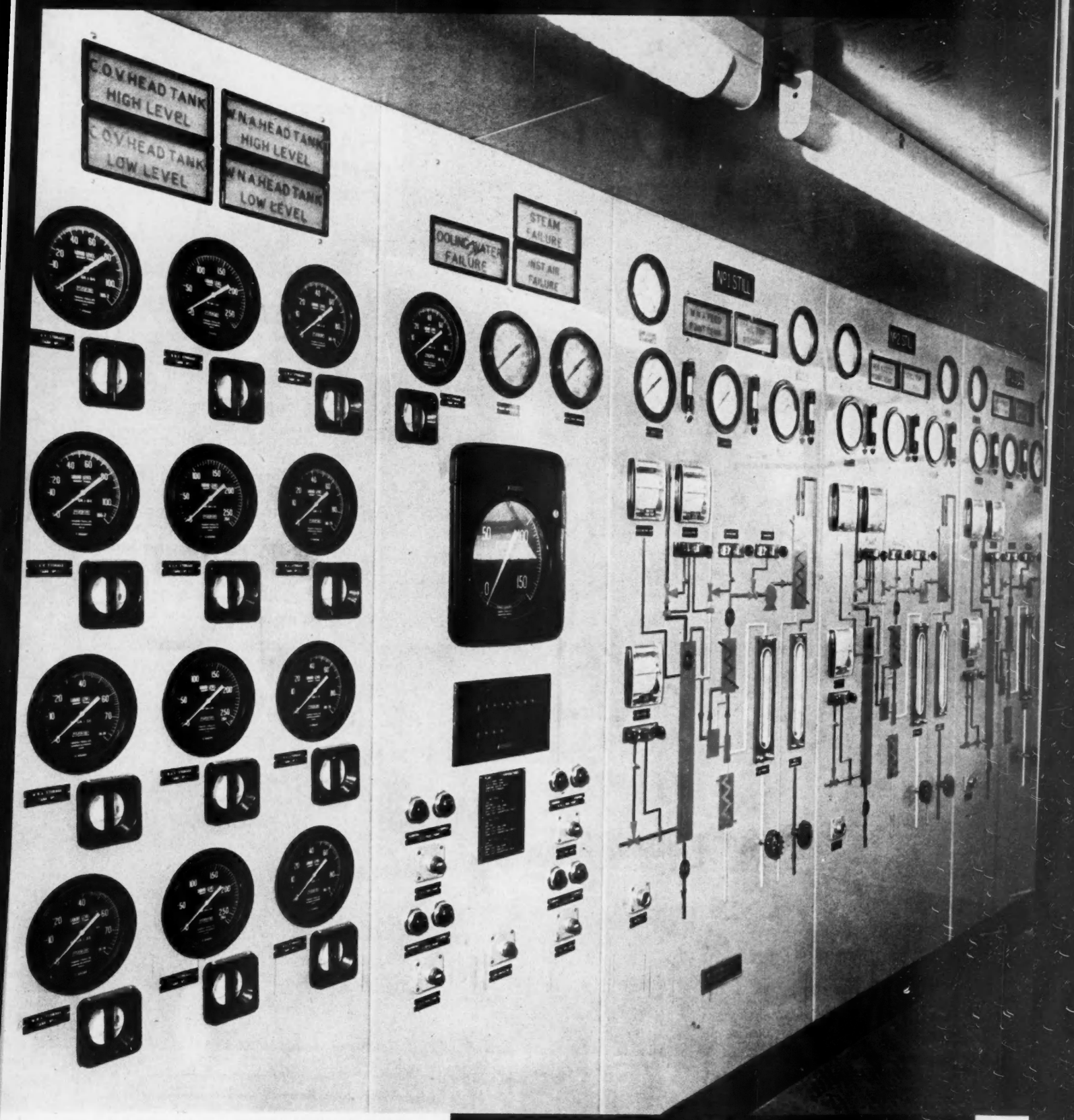


The Power behind ARMOURCHROME

Precision inspection

THE BRIGHTSIDE PLATING COMPANY LTD.,
Brearley Street · Birmingham 19 · *Tel: Aston Cross 2663*

INSTRUMENTATION and CONTROL



Matthew Hall & Co. Ltd. designed and installed this control panel with associated instrumentation for a chemical plant. It provides a centralized position for the automatic control and indication of temperature, flow, pressure and liquid level, together with a process alarm system.

THE
MATTHEW HALL
GROUP OF COMPANIES

SYSTEMS DESIGN, ERECTION AND COMMISSIONING

EST. 1848

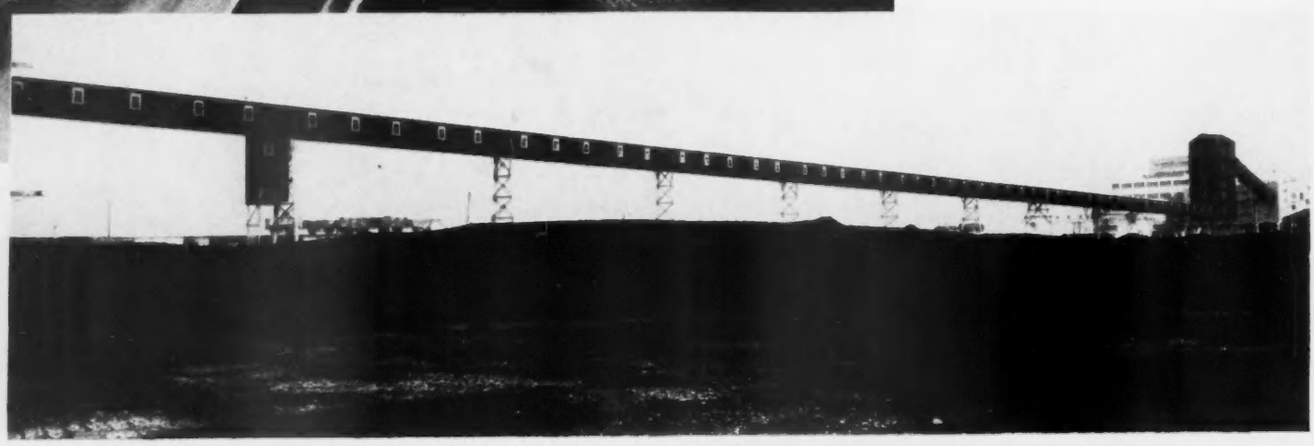
MATTHEW HALL

MATTHEW HALL HOUSE, DORSET SQUARE, LONDON, N.W.1.

Glasgow Manchester Bristol Belfast Johannesburg Germiston Durban
Cape Town Welkom Bulawayo Salisbury (Central Africa) Ndola West Indies

SPENCER HANDLING PLANT SPEEDS THE FLOW OF COAL

Spencer 30in. troughed belt conveyor, nearly 1,000 feet long carrying 200 tons of coal per hour in overhead gantry from Weighing and Sampling Tower to the Central Electricity Generating Board's Power Station at Bold.



SPENCER (MELKSHAM) LIMITED
MELKSHAM · WILTSHIRE

SPENCER
HANDLING PLANT

Branch Offices
Ingersoll House, 9, Kingsway, London, W.C.2 Tel.: Covent Garden 1800
34, Castle Street, Liverpool, 2 Tel.: Central 3738

MONOCABLE & BICABLE SYSTEMS CABLEWAYS

Over Sixty Years' Service to the mining Industry throughout the World

Catalogue sent on request

ROPEWAYS LTD

62 LONDON WALL, LONDON, E.C.2.

Telephone: National 0124/5 *Telegrams: "Ropeways" London*

BROADBENT & CO. (ROCHDALE) LTD.

Grove Spring Works, LINCOLN STREET, ROCHDALE, Lancs. *Phone:-Rochdale 4628-9*

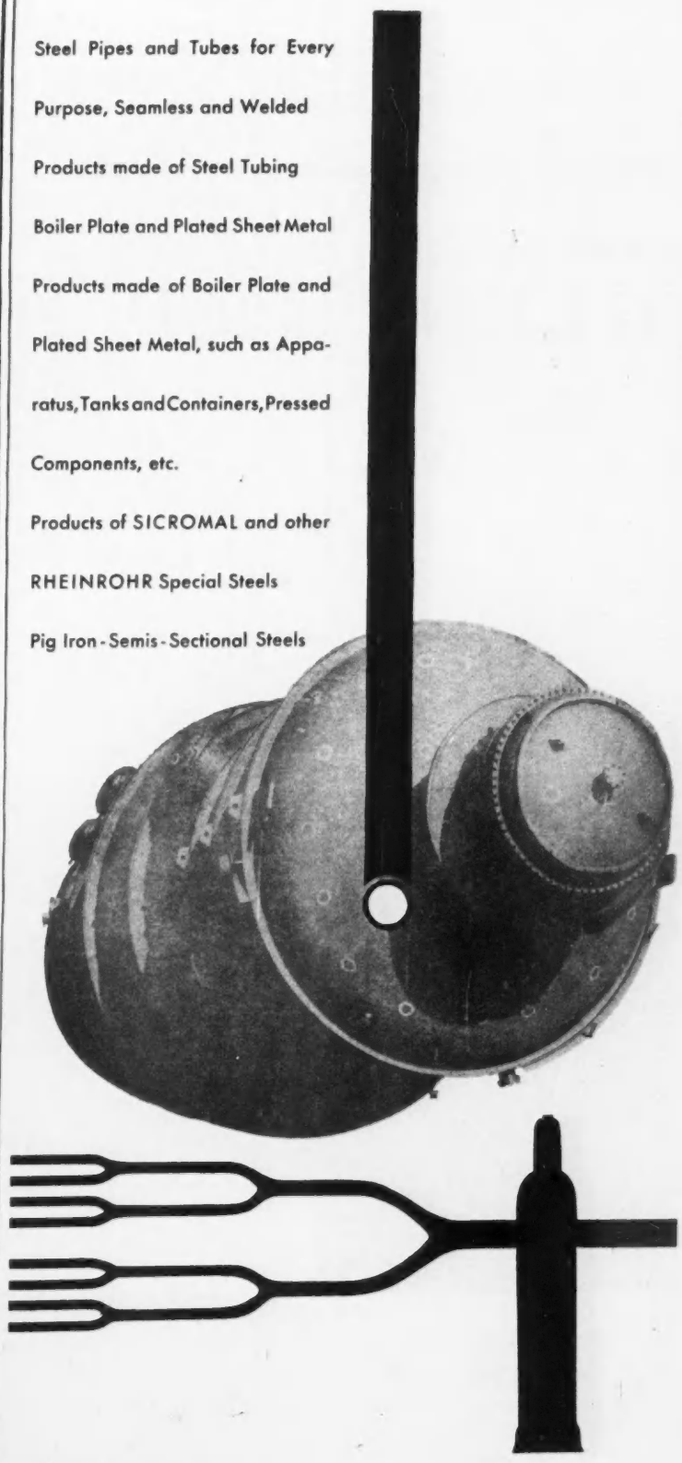
Steel Pipes and Tubes for Every Purpose, Seamless and Welded

Products made of Steel Tubing Boiler Plate and Plated Sheet Metal

Products made of Boiler Plate and Plated Sheet Metal, such as Apparatus, Tanks and Containers, Pressed Components, etc.

Products of SICROMAL and other RHEINROHR Special Steels

Pig Iron - Semis - Sectional Steels

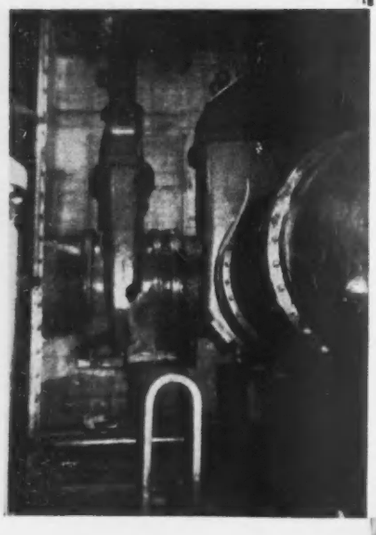


PHOENIX-RHEINROHR AG

VEREINIGTE HÜTTEN- UND RÖHRENWERKE DÜSSELDORF

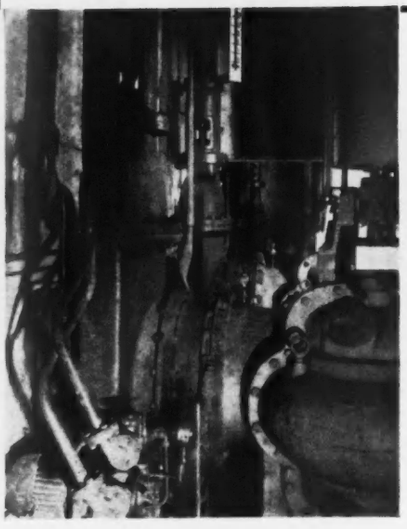
GLENFIELD VALVES

For Dry Docks



Dublin Port & Docks Board's new dry dock is yet another important installation of its kind incorporating Glenfield Valves to give efficient and reliable control during impounding and de-watering operations.

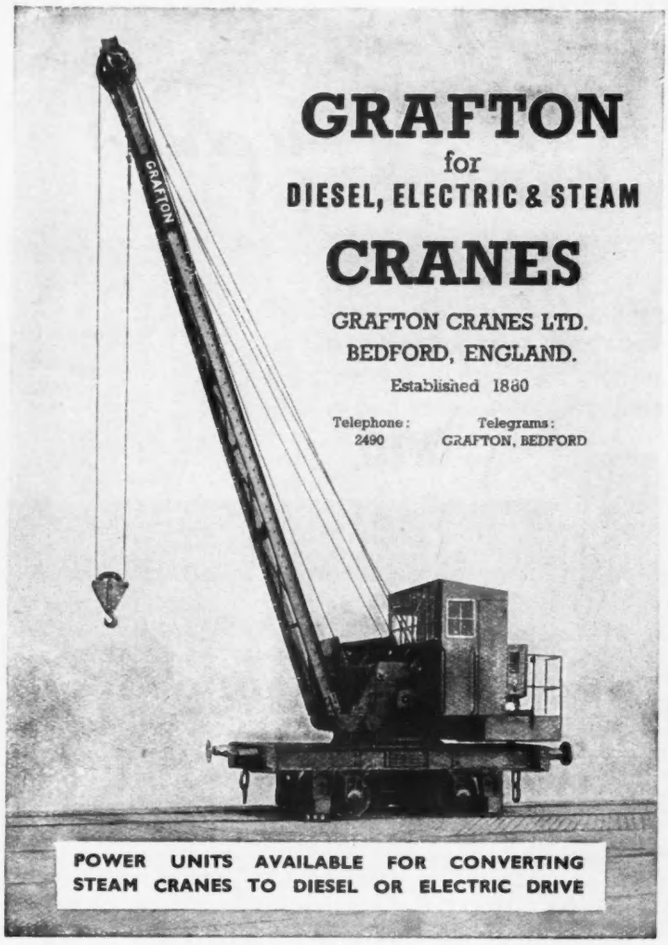
All the Valves, ranging in size from 3 to 60 in dia., for the pumping station, the culverts, the caissons and the dockside services were supplied by this company. Illustrated, left, are 27 in dia. hydraulically operated automatic self-closing Gwynne-Glenfield sluice valves on the main discharge pump delivery lines; and, below, 60 in dia. electrically-driven Glenfield units at a culvert bifurcation.



Glenfield

GLENFIELD & KENNEDY, LIMITED, KILMARNOCK

Head Office & Works: KILMARNOCK, SCOTLAND



GRAFTON
for
DIESEL, ELECTRIC & STEAM
CRANES

GRAFTON CRANES LTD.
BEDFORD, ENGLAND.
Established 1880

Telephone: 2490 Telegrams: GRAFTON, BEDFORD

POWER UNITS AVAILABLE FOR CONVERTING STEAM CRANES TO DIESEL OR ELECTRIC DRIVE

KINNEAR SHUTTERS
by the makers of Kinylon and Kinrod Grilles

solve the problem

of wide entrances and a sloping road. The bottom rails on these Kinnear Shutters are shaped to accommodate the rise of the road, to ensure good closure and complete weather protection.

Please send for illustrated leaflet 7B

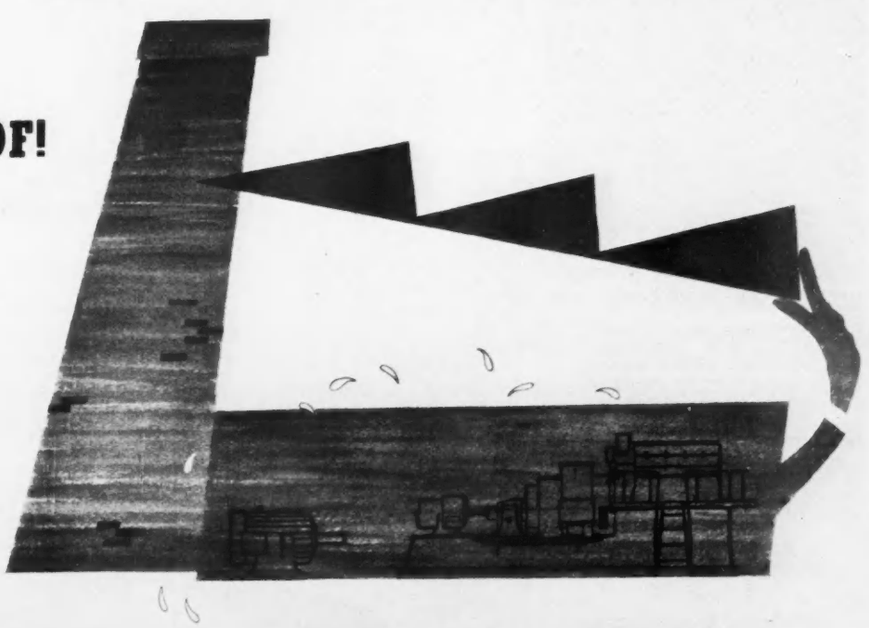
ARTHUR L. GIBSON & CO. LTD., TWICKENHAM, MIDDLESEX.
Telephone: Popesgrove 2276. *Birmingham:* Highbury 2804.
Glasgow: Halfway 2928. *Manchester:* Central 1008. *Cardiff:* 51428

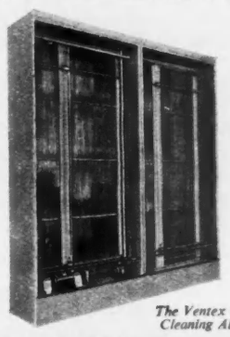
DON'T RAISE THE ROOF!

When motors run hot there is a more efficient method of cooling than raising the roof, opening windows, or even fanning them with a newspaper.

" Ventex " air cooling system ensures a continuous flow of air reaching vital fast moving parts, keeping temperature down and production up.

For details of our full range of Air Cooling and Air Filter Systems, or any cooling or filtering problems you may have, write to us.





The Ventex Continuous Cleaning Air Filter.

VENTEX *Air Filters*

OZONAIR ENGINEERING COMPANY LIMITED,
THE ESPLANADE, ROCHESTER, KENT. 'Phone: Chatham 45011/PBX

BRETT

DROP FORGING EQUIPMENT

BRETT'S PATENT LIFTER Co LTD
FOLESHILL WORKS, COVENTRY
Phone 89038 Grams "LIFTERS" COVENTRY

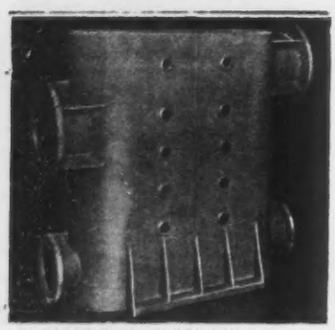
FARRAR BOILERS

FOR ALL INDUSTRIAL PURPOSES

including installations for
GASWORKS · HOTELS
HOSPITALS · SCHOOLS
PITHEAD BATHS
PUBLIC BUILDINGS
GRAIN SILOS Etc.

THE FARRAR BOILERWORKS
NEWARK (NOTTS) ENGLAND
Telegrams: Farrar, Newark 1143
Telephones: Newark 1143-4-5

RAISE STEAM WITH A "FARRAR"



RICHMOND WELDING CO.

Fabrications Large and Small. Stainless Steel. Copper and Aluminium Welded by the Argon Arc or the Argonaut Process. Engineering.
Tel: BRADFORD 25405
Established 1929

We supply

COMPLETE PLANT
for
Waste Recovery
and
Effluent Treatment

NORRIS BROS. LTD.
53 VICTORIA STREET, S.W.1
Tel: Abbey 6132
DESIGNERS AND SUPPLIERS OF ALL PROCESS PLANT

USE Eclipse HACKSAW BLADES

and feel the difference!

'Eclipse' hacksaw blades and other tools are made by James Neill & Co. (Sheffield) Ltd. and are obtainable from all tool distributors.

UH27

Faster-more efficient

BOILER CLEANING

Why waste time brushing smoke tubes, and rodding clinker and birds nesting, when a few minutes with a Percussion Lance will shift everything from Economisers, Airheaters, Water Tubes, Fire Tubes, etc.

See this new cleaning tool in action at your own works— write to
AIRNESCO PRODUCTS LIMITED
KNIGHT ROAD, STROOD, ROCHESTER, KENT
Telephone: Strood 78310

AIRNESCO Percussion LANCE

SMITHS

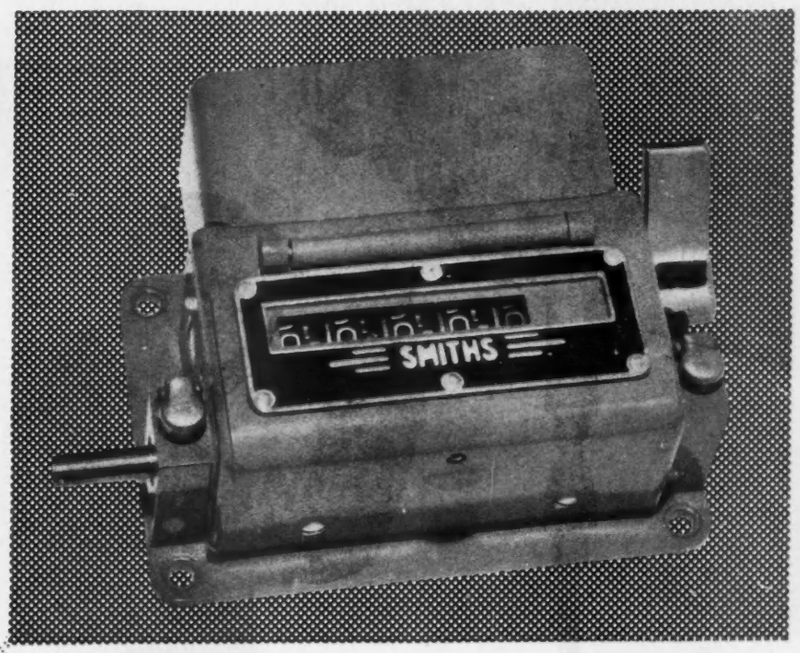
for Good Measure

To Industry, the name SMITHS has a world of meaning. It includes a reputation for Good Measure, good measure in the sense of the long-term accuracy of their industrial instruments, good measure in terms of the service offered by unrivalled research and test facilities. This latter, may be said to be immeasurable.

Predetermined Counters

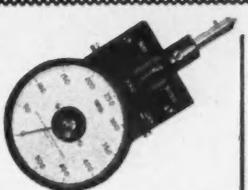
For indicating a pre-set number between 1 and 99,999.

This instrument has been introduced to provide a form of control capable of eliminating losses caused by over- or under-production, particularly on applications requiring a precise and repetitive length or number of units—lengths of cloth, coil windings, packaging and batching machines, for example.



Specification

Body:	Die-cast alloy, reasonably dust- and dirt-proof.
Counter:	White on black figures.
Speed of Count:	4,000 counts/min. Maximum Shaft Speed: 5,000 r.p.m.
Drive:	R.H. or L.H., plain shaft or flex attachment.
Rotation:	Top going or top coming.
Micro Switch:	Supplied in wide choice of agreed manufacturer/client ratings.
Total Weight:	With flex attachment, 2 lb.; plain shaft, 1 lb. 15 oz.



Hand Tachometers for checking rotary, linear and surface speeds

Transistor Batch Counters for high speed counting and batching of repetitive quantities

Electric Tachometers a.c. and d.c. and three phase

"Petro-flex" Flexible Tubing for the conveyance of all non-acid fluids

Synchronous Hours Counters for indicating life of equipment in a.c. circuits

Calibrated Relays for the control of voltage, current and speed to ±1% accuracy

For Good Measure in Industrial Instruments specify SMITHS

WRITE NOW FOR INDIVIDUAL LEAFLETS

SMITHS INDUSTRIAL INSTRUMENT DIVISION

Chronos Works, North Circular Road, London, N.W.2. Telephone: GLAdstone 1136

AP188/385

ARCHDALE

"Pre-select"

FOR GREATER OPERATING SPEEDS —FASTER PENETRATING CAPACITY

Shown in use at The Electric Construction Co. Ltd., Wolverhampton, this ARCHDALE mechanical 'Pre-select' is fully meeting our claims to cut production times to a minimum. Not only are penetration rates as high as power and rigidity can make them, but much valuable time is saved by convenient pre-selection from 16 spindle speeds, at any time whether the spindle is running or stationary. Spindle speeds range between 15 and 1500 r.p.m. and the six rates of feed, selected by a single lever, between 24 and 400 R.P.I.

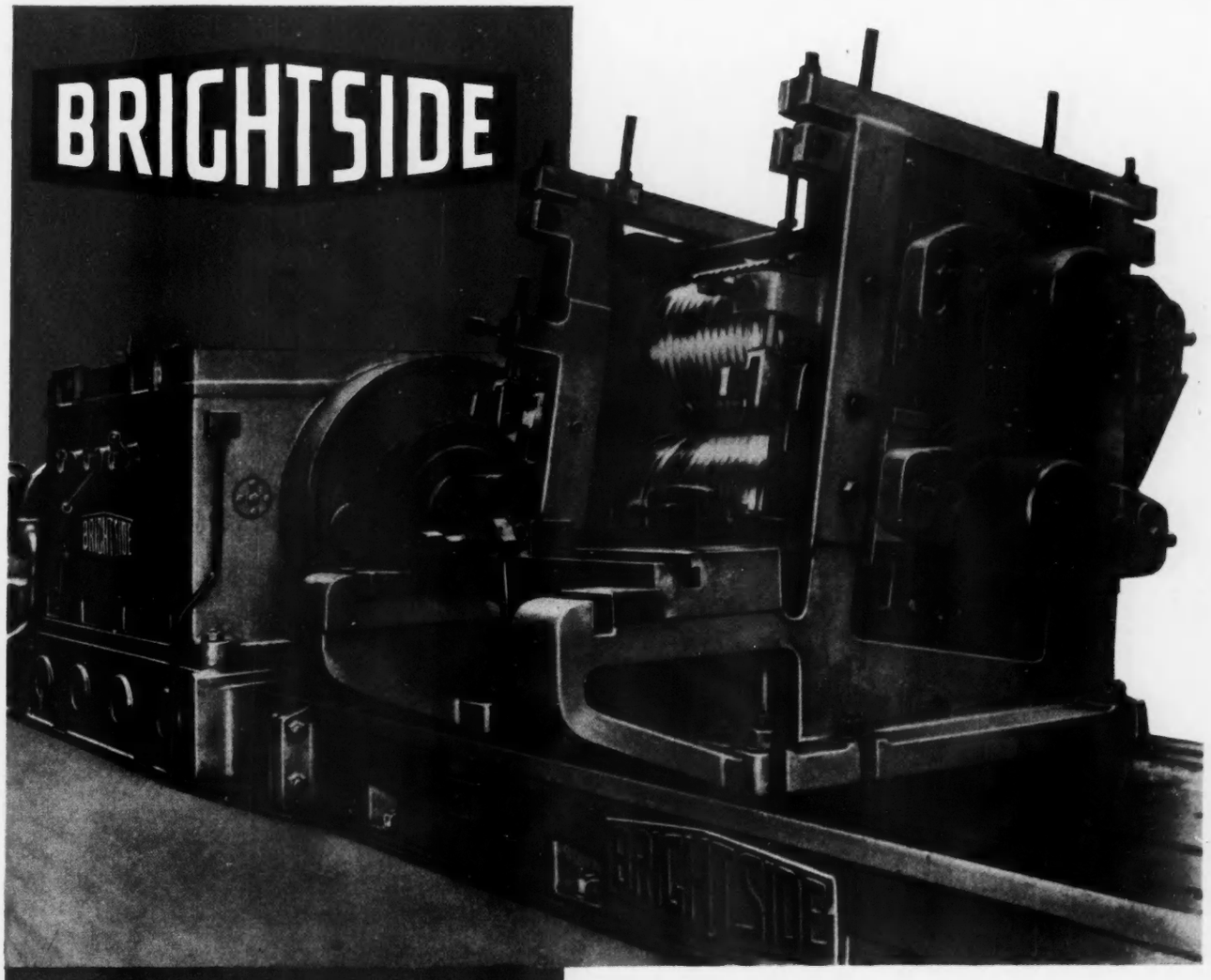
N.B. The illustration shows the drilling and spot facing of main fixing holes in end brackets for 250 B.H.P. electric motors.

JAMES ARCHDALE & CO. LTD., LEDSAM ST., BIRMINGHAM, 16

Telephone : EDGbaston 2276 - - - A member of the Staveley Coal & Iron Co. Ltd. Group

Sole Agents : ALFRED HERBERT LTD., COVENTRY. Telephone : 89221

BRIGHTSIDE



HOT AND COLD ROLLING MILLS.

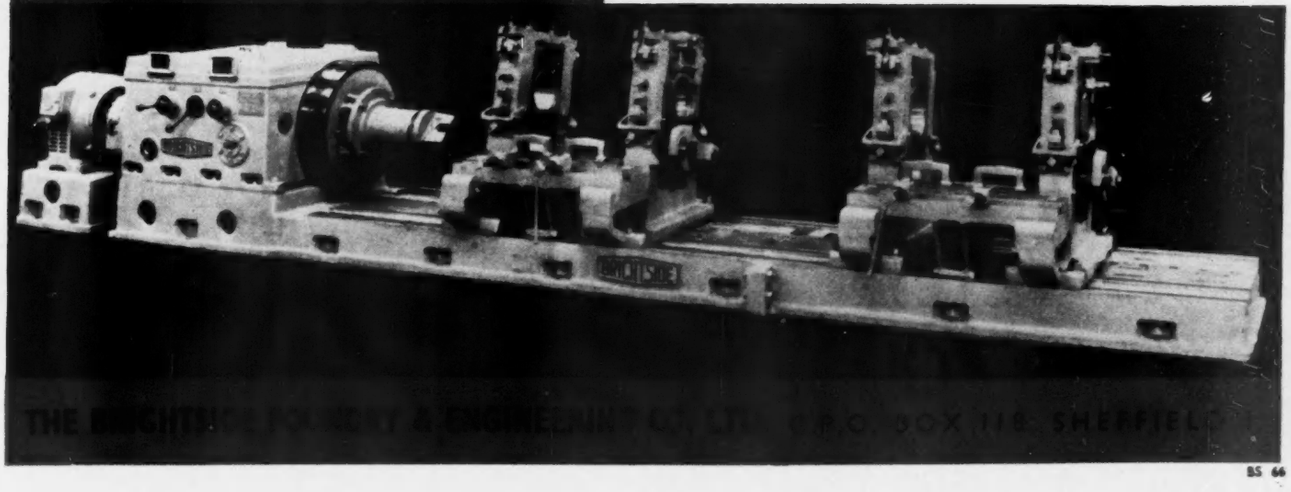
ROLLS FOR HOT AND COLD ROLLING.

ROLL LATHES.

HOT AND COLD SHEARS.

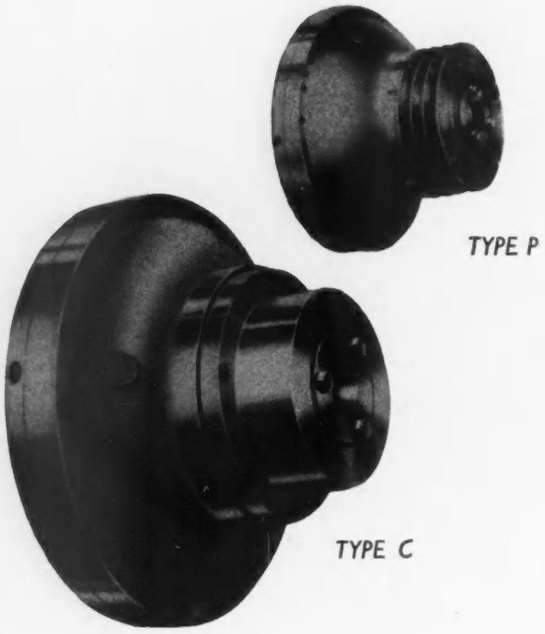
HOT SAWS AND REELERS.

STEELWORKS PLANT AND AUXILIARIES.



BS 66

M



Wherever power is used Crofts Couplings play a vital role . . .

CROFTS (ENGINEERS) LIMITED Thornbury Bradford 3 Yorkshire

Crofts Hydraulic Couplings and Drives

FRACTIONAL TO 290 H.P. — LARGER SIZES ON REQUEST

- Stallproof, cushioned power transmission
- Permits use of cheaper, smaller motors and starters
- Gives longer, protected machinery life
- Type C, for use as a shaft coupling
- Type P, for V-rope and belt drives
- Every Drive Guaranteed

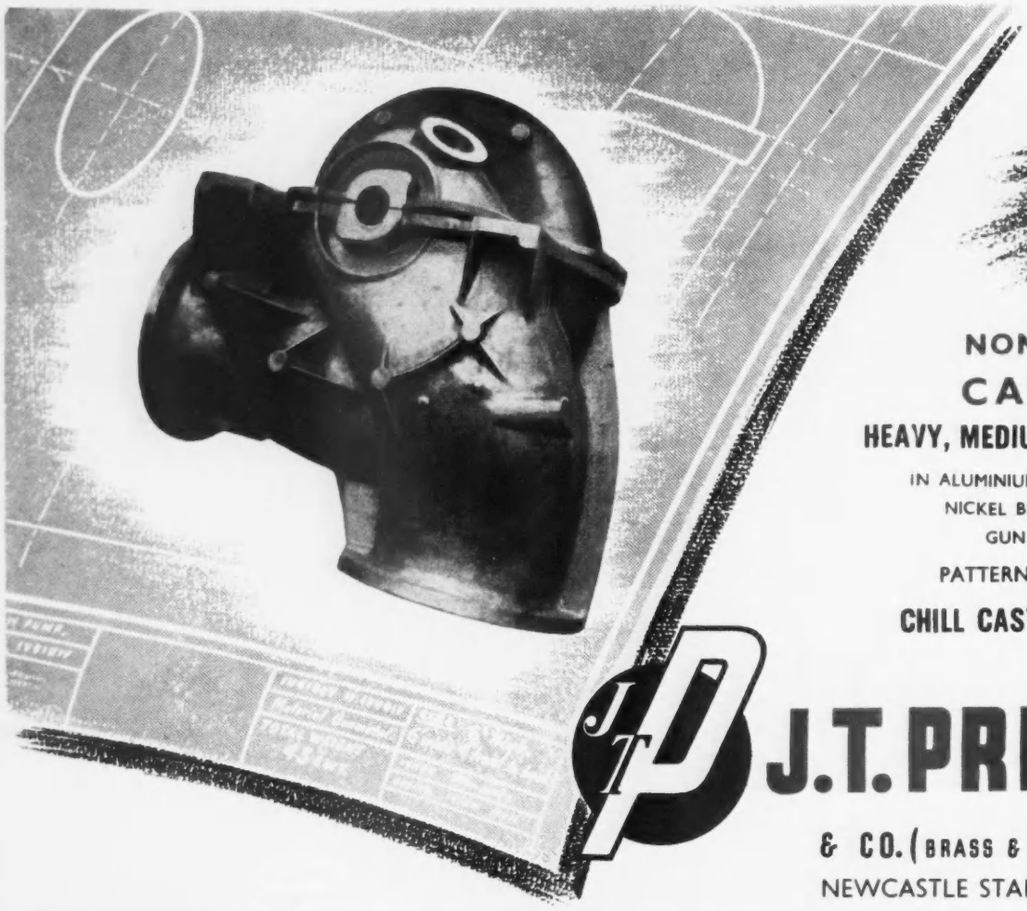
SEND FOR PUBLICATION 5814/A

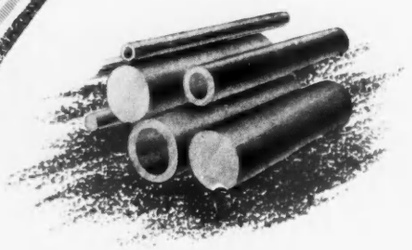
CROFTS (ENGINEERS) LIMITED
POWER TRANSMISSION ENGINEERS
Thornbury, Bradford 3, Yorkshire
Tel.: 65251 (20 *lines*) *Grams :* '*Crofters Bradford Telex*' *Telex* 51186

Makers of: Clutches, Conveyor drives, Couplings of all types, Double helical gear units, Fabricated steelwork, Geared motors, Hydraulic couplings, Iron, steel and non-ferrous castings, Machine-cut gears of all types, Motorised rollers, Patent Taper-Flushbushes, Plummer blocks, Shaft-mounted gear units, Special machinery drives, Spiral bevel gear units, Turbine gears, V-rope drives, Variable speed drives, Worm reduction gears.

Branches at: Belfast Birmingham Bristol Cardiff Dublin Glasgow Ipswich Leeds Liverpool London Manchester Newcastle Northampton Nottingham Sheffield Stoke-on-Trent

REPRESENTED THROUGHOUT THE WORLD





NON FERROUS
CASTINGS
HEAVY, MEDIUM and LIGHT SAND CASTINGS
IN ALUMINIUM BRONZES, MANGANESE BRONZES,
NICKEL BRONZES, PHOSPHOR BRONZES,
GUN METALS, ALUMINIUM, etc.
PATTERN MAKING and MACHINING
CHILL CAST SOLID and CORED BARS

J.T. PRICE
& CO. (BRASS & ALUMINIUM FOUNDERS) LTD
NEWCASTLE STAFFS · PHONE 52311 (3 lines)

MARS-LUMOGRAPH
DRAWING AND BLUE-PRINT PENCILS

are specially produced to meet the needs of architects, draughtsmen and others who require pencils of the highest quality.

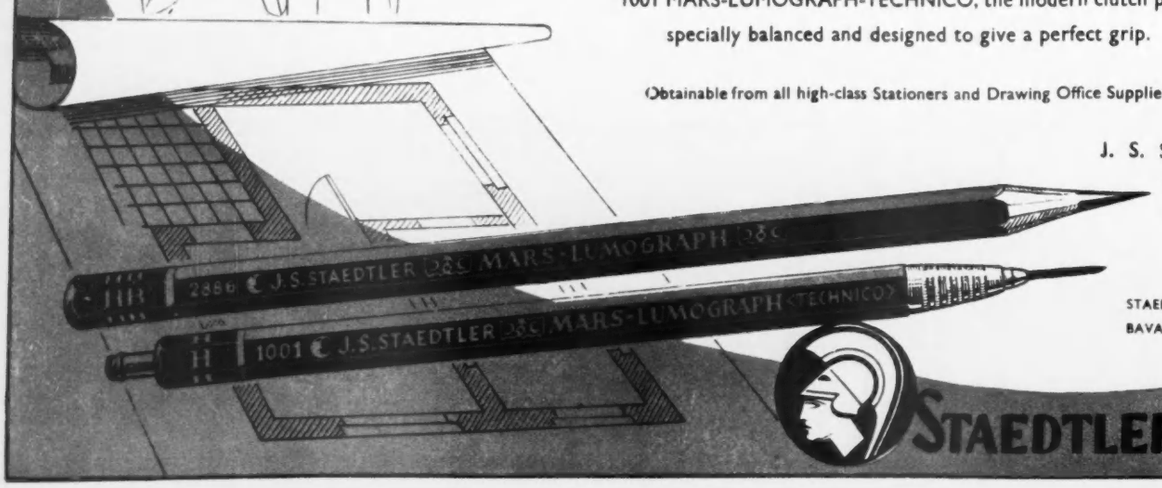
They give a clear black line, not easily smudged, and are specially treated with a patent substance that gives perfect blue-prints.

2886 MARS-LUMOGRAPH, cedar wood pencils available in 19 different degrees.

1001 MARS-LUMOGRAPH-TECHNICO, the modern clutch pencil, in 15 degrees specially balanced and designed to give a perfect grip.

Obtainable from all high-class Stationers and Drawing Office Suppliers, Trade enquiries to:

J. S. STAEDTLER, Ltd.,
83 Copers Cope Road,
Beckenham, Kent.



STAEDTLER PENCILS MADE IN BAVARIA SINCE 1661

STAEDTLER-MARS

POLYESTER DOUGH MOULDING COMPOUND for

Transformer Housings	Heavy duty plugs & sockets
Fire extinguisher nozzles	Contactor Bodies
Ventilation & Heating Ducts	Vacuum Cleaner Housings
Refrigerator door locks and shelf brackets	Insulating handles & covers for electrical appliances
Industrial Fuse boxes	Double insulation
Switchgear Housing	Busbar holders
Coil Formers	Slip ring motor insulators
Industrial Switch Dollies	Boxes
	Panels

BEETLE DMC

HIGH DIMENSIONAL STABILITY

GOOD SHOCK RESISTANCE

GOOD HEAT RESISTANCE

Beetle DMC is a fibrous dough moulding compound consisting of an unsaturated polyester resin incorporating mineral fillers and reinforcing fibres. It is economical because it is fast and simple to mould under low pressure in conventional compression presses. Mouldings made from this material have high mechanical and electrical strength, excellent dimensional stability and insulating properties. DMC opens up a host of new applications for plastics and in certain cases may be used to replace alloy castings.

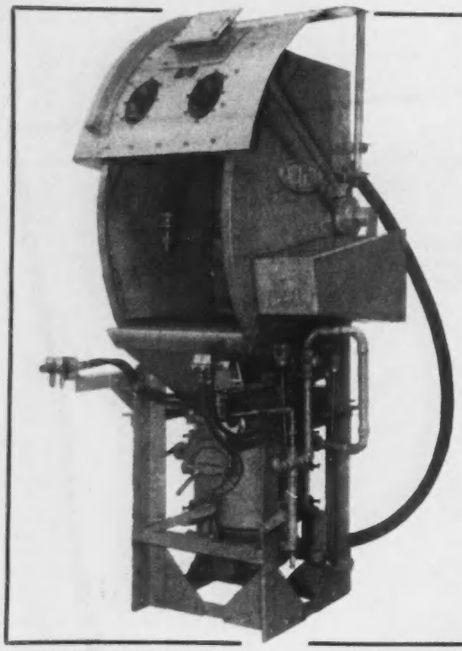
Two glass-filled grades are available — Grade A for general purposes and for electrical components; and Grade B — a self-extinguishing material. Write for full details.

PLUS A **New** GENERAL PURPOSE DMC: SISAL FILLED GRADE C

B.I.P. CHEMICALS LIMITED B·I·P

OLDBURY · BIRMINGHAM · PHONE: BROADWELL 2061

N



JACKMAN FOR SHOT BLAST EQUIPMENT

WE ILLUSTRATE OUR TYPE 52 RUBBER LINED SHOT BLAST CABINET A COMPACT MACHINE REQUIRING THE MINIMUM OF FLOOR SPACE AND PROVIDING KNEE ROOM TO ENABLE THE OPERATOR TO SIT.

THE PIVOTED CURVED DOOR GIVES FULL WIDTH OPENING TO AN INSIDE AREA 32" WIDE x 24" DEEP OR 24" WIDE x 24" DEEP.

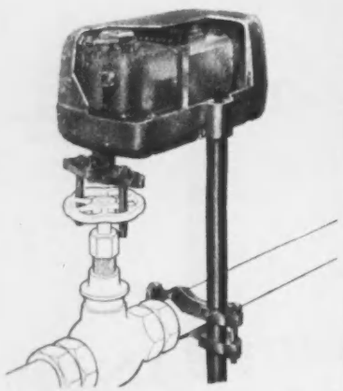
MOVEMENT OF THE COUNTERBALANCED DOOR IS BY AIR CYLINDER THROUGH TWO HANDED VALVE CONTROL TO ENSURE OPERATOR SAFETY.

THE DOOR IS CLEAR OF THE SOFT RUBBER SEAL WHEN LIFTING OR LOWERING, AND SEALS WHEN CLOSING.

BLAST CONTROL IS BY FOOT PEDAL.

FOR STANDARD OR SPECIAL SHOT BLAST EQUIPMENT SEND YOUR ENQUIRIES TO

J. W. JACKMAN & COMPANY LTD.
VULCAN WORKS: BLACKFRIARS RD., MANCHESTER, 3.
Telephone: DEANSGATE 4648-9 *Telegrams:* BLAST, MANCHESTER.



VALVE MOTORISATION by ROTORK

Rotork electric actuators can be operated by push button, or automatically from any distance.

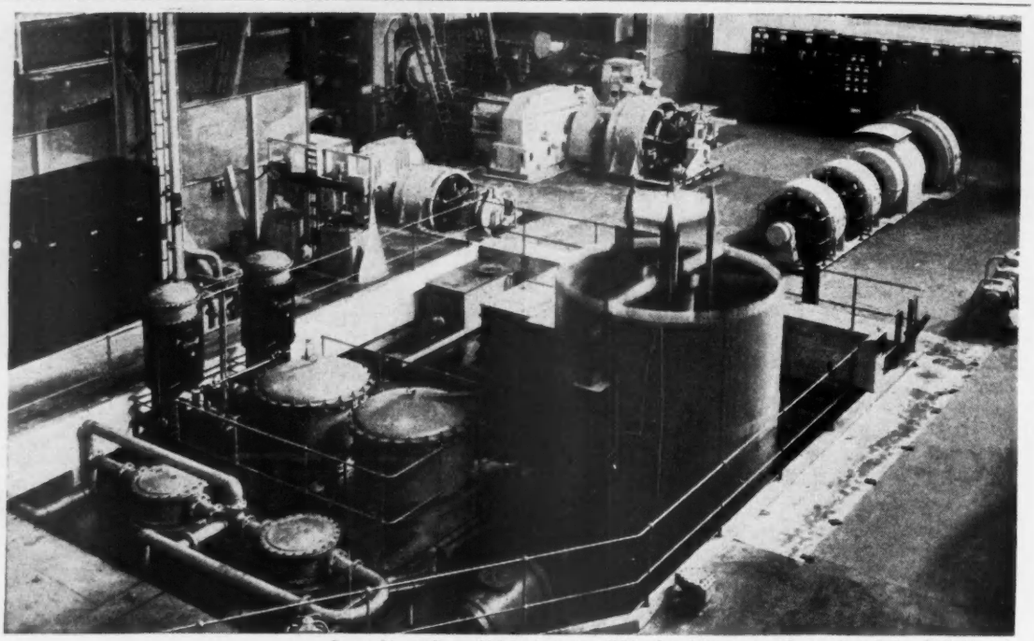
The "Junior" model illustrated (type 1F) will operate any valve with a handwheel which a man can close with one hand. No modification to the valve is needed.

A worm and spur type reduction gear box, grease packed and totally enclosed in a weatherproof case, is driven by a small universal type motor suitable for 200-250V. A.C. single-phase supply.

Examples of typical sluice valve applications are : ½" at 2,000 p.s.i., 1" at 400 p.s.i., 2" at 125 p.s.i., and 3" at 30 p.s.i.

Full information about this and other Rotork actuators supplied on request.

ROTORK ENGINEERING CO. LTD
BATH · Telephone : 64558



Stream-Line cooling and lubrication system. With acknowledgements to Shepcote Lane Rolling Mills Limited.

Stream-Line Lubrication Systems For Heavy Machinery

Are you looking for a complete, centralised lubrication system for your mill? If so, Stream-Line Filters will be glad to help. It's over 25 years since we installed our first lubricating and Purification System in a Steel Bar Mill. To-day, over 50 mills for steel, aluminium and non-ferrous rolling have been equipped with Stream-Line Systems. Similar systems have also been fitted to Paper mills and large rock crushers for the cement industry. Our engineers will be glad to discuss your problems at any time. Write for the Stream-Line Lubrication System Booklet.

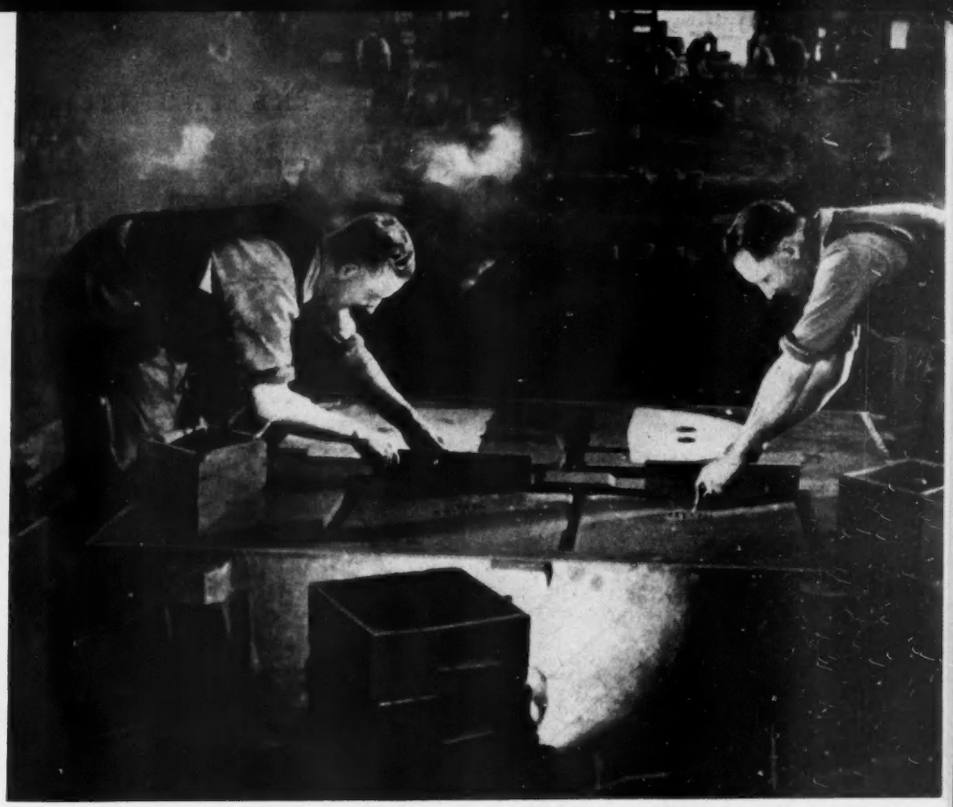
WELL-KNOWN FIRMS USING STREAM-LINE LUBRICATION SYSTEMS INCLUDE:—

Lancashire Steel Corporation,
Guest, Keen & Nettlefolds,
Steel Peech & Tozer,
Stewarts & Lloyds,
John Lysaght,
Reynolds Rolling Mills,
British Aluminium,
Colvilles,
Vickers-Armstrongs,
Appleby-Frodingham,
James Booth,
Associated Portland Cement,
Imperial Chemical Industries.

STREAM-LINE FILTERS ***make oil lubricate longer***

STREAM-LINE FILTERS LTD.
Ingate Place, London, S.W.8
Telephone: Macaulay 1011

SF.23



NEWTON CHAMBERS now cast in MEEHANITE

Our large modern foundries at Thorncliffe can now produce all classes and sizes of castings in the various types of Meehanite metal. This important addition to our already very extensive foundry facilities enables us to offer an exceptionally skilled and comprehensive casting service. Our long experience of serving almost every major industry gives us a unique understanding of special needs and problems.

Whether you require one casting or thousands, we can meet your needs promptly, in sizes from a few pounds up to 20 tons in weight. Production methods include light, medium and heavy machine moulding, as well as floor, loam and shell moulding. A skilled patternmaking service is at your disposal. Your machining and fitting requirements can be undertaken by our fully modernised machine shops.

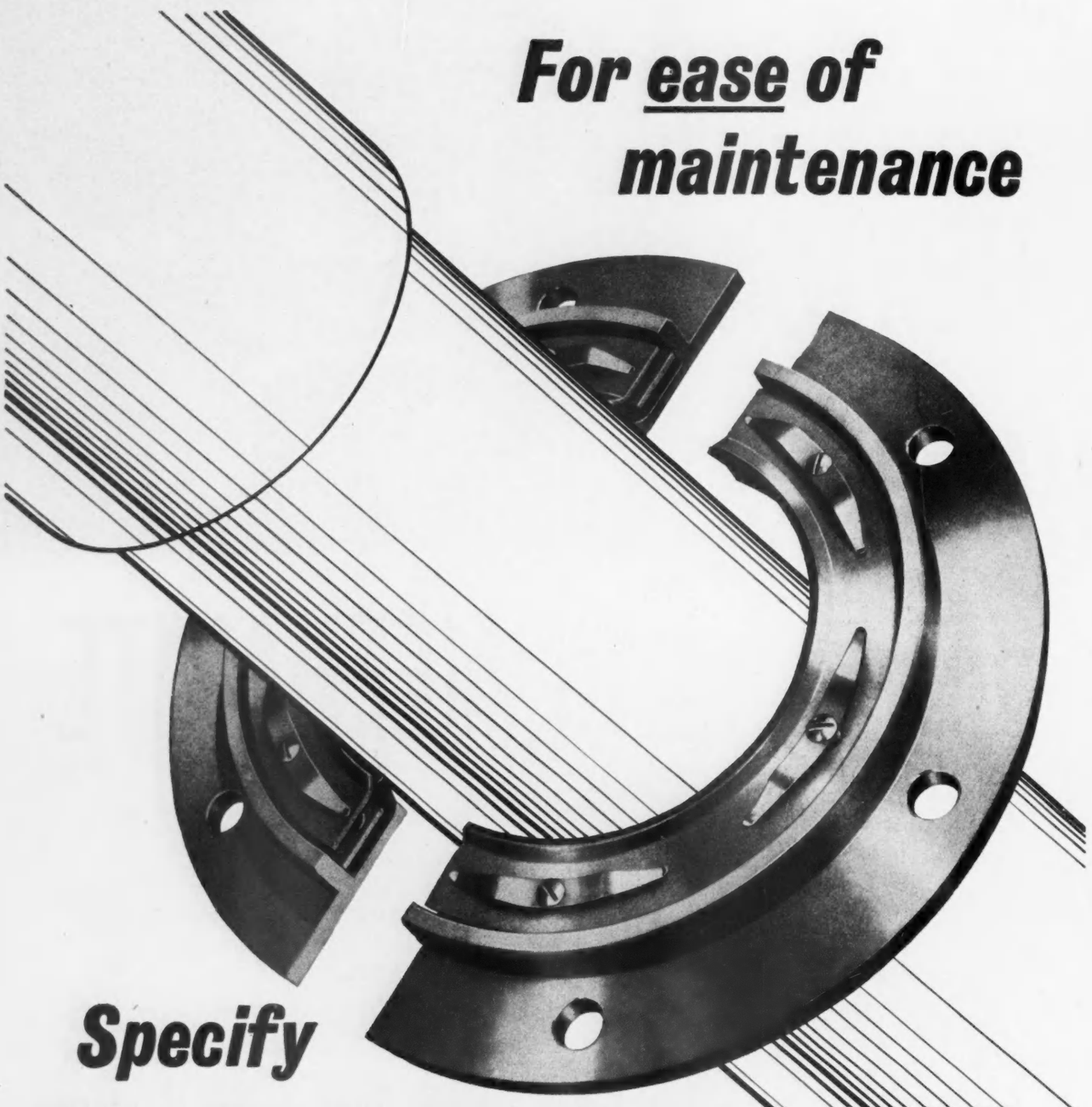
All enquiries will receive immediate attention

Newton Chambers

ENGINEERING DIVISION · THORNCLIFFE · SHEFFIELD

ENGINEERS OF PROGRESS

For ease of maintenance



Specify

WESTON

SPLIT SEALS

CHARLES WESTON & CO. LTD. Irwell Bank Works · Douglas Green · Pendleton · Salford 6

Telephone : Pendleton 2857-8-9 ; Telex 66-255 ; Birmingham Erdington 5459 ; London Holborn 0414 ; Telex 2-2582

- BETTER TRY 600 FIRST !

FOR HYDRAULIC PRESSES

4000-ton U/S Press by **JOHN SHAW,** ram 41in. diam. by 21in. stroke, table 5ft. square, daylight 24in., w.p. 3 tons per square inch, c.w. pumps and control gear. Ideal for die sinking.

1200-ton Double Acting by **FIELDING & PLATT,** downstroking ram 26in. diam., 27in. stroke, upstroking ram 24in. diam., 24in. stroke, fixed and moving tables 5ft. diam., daylight 3ft. 9in., working pressure 5000 lb. per square inch.

750-ton Downstroke by **T. H. & J. DANIELS,** moving cylinder type, ram 22in. diam., 3ft. stroke, tables 4ft. 9in. by 3ft. 7in., daylight 48in., w.p. 2 tons per square inch.

500-ton Downstroke by **HYDRAULIC ENGINEERING CO.,** Chester, ram 18in. diam., 30in. stroke, tables 54in. by 42in., daylight 40in., w.p. 2 tons per square inch.

300-ton Downstroke by **M. B. WILD,** ram 20in. diam., 48in. stroke, tables 36in. by 28in., daylight 60in., w.p. 1 ton per square inch.

200-ton Overhung Downstroking by **HUGH SMITH,** ram 20¾in. diam., 20in. stroke, bed 54in. by 50in., table 32in. diam., gap 30in., daylight 31in., c.w. jib crane.

150-ton Upstroke by **DEWRANCE,** ram 14in. diam. by 28in. stroke, tables 48in. diam., daylight 42in., w.p. 1 ton per square inch.

100-ton Overhung by **HENRY BERRY & COMPANY,** ram 8in. diam., 20in. stroke, daylight 30in., gap 19in., w.p. 2 tons per square inch.

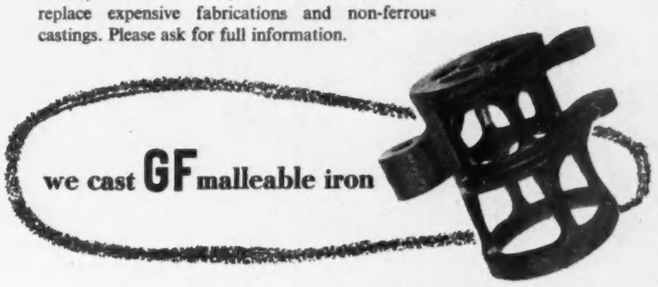
Horizontal Hydraulic Pipe Bending or Straightening Press by **FIELDING & PLATT,** ram 8in. diam., 20in. stroke, c.w. pumps, control gear and heads and dies.

GEORGE COHEN
SONS AND COMPANY LIMITED

THE 600 GROUP OF COMPANIES

SUNBEAM RD., LONDON, N.W.10. *Tel. Elgar 7222*
STANNINGLEY, Near LEEDS. *Tel. Pudsey 2241*

There's no magic about **GF** Malleable Iron: no illusion about its superiority either. Here is an engineering material that is stronger and better than ordinary whiteheart malleable iron: more consistent, more machinable, more ductile. It can often replace expensive fabrications and non-ferrous castings. Please ask for full information.



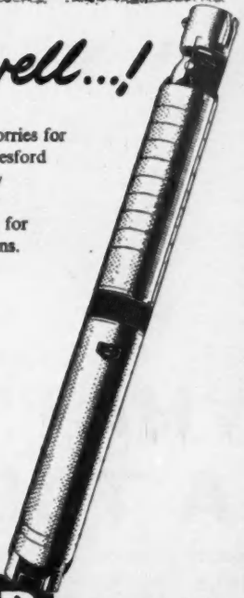
Our metallurgists and technicians will be happy to consider your problems and to advise without obligation.

GF MALLEABLE CASTINGS

BRITANNIA IRON & STEEL WORKS LIMITED
A member of the George Fischer Group (Switzerland)
BEDFORD Telephone: Bedford 67261 **ENGLAND**

Well, well, well...!

Three wells and no more water worries for the owners—if each well has its Beresford Submersible pump installed below water level, quietly and efficiently providing all the water required, for little more than 1d. per 1,000 gallons. They're ideal for automatic operation, are made of non-corrosive bronze and stainless steel, occupy no surface space and cause no nuisance. They are, in fact, the ideal modern pumps for domestic, agricultural and industrial water supply, particularly for use in deep wells and bore-holes. May we send you a copy of descriptive leaflet P.G.300 ?



BERESFORD submersible **pumps**

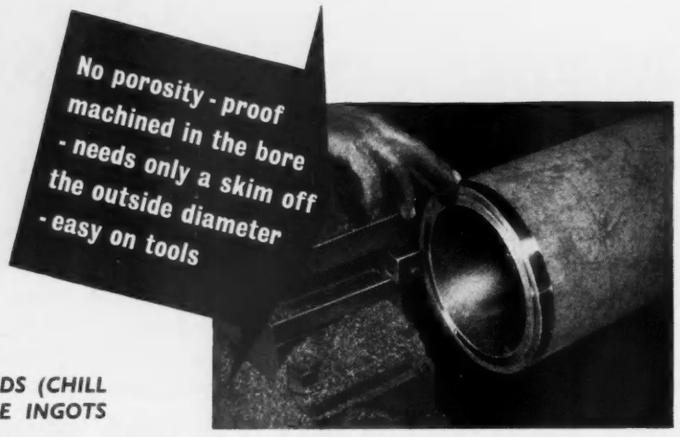
James Beresford & Son, Limited,
(The Cornercraft Group of Companies)
Ace Works, Kitts Green, Birmingham, 33
Telephone: Stechford 3081
Branches and Agents throughout Britain and overseas

BM.237

Cut Machining Time and Cost—Specify ESCO 'Rotocast'

BRONZE BUSHING GEAR BLANKS

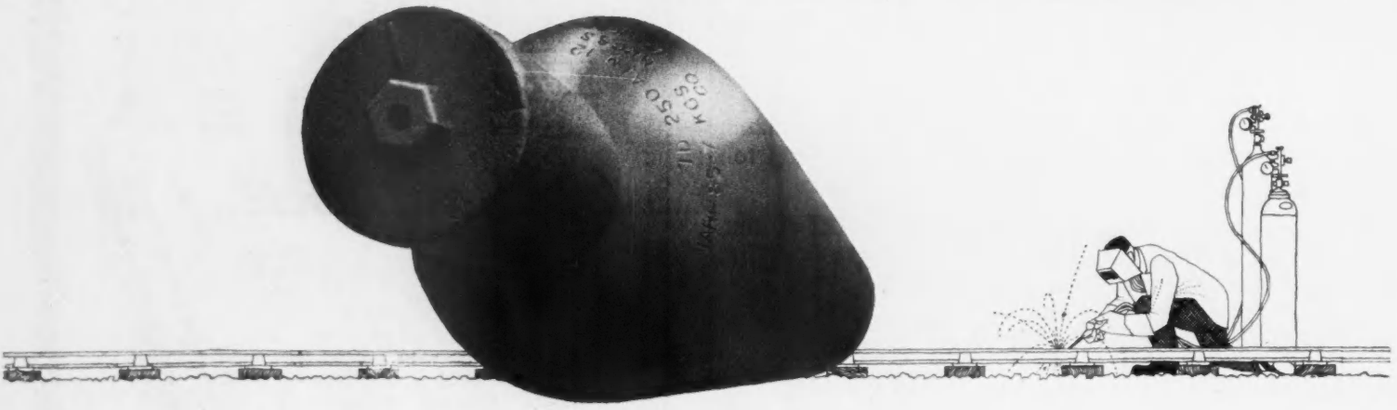
★ The inside diameter is supplied rough machined.
Standard 13″ lengths



THE **EYRE** SMELTING CO. LTD.

Makers of TANDEM WHITE METALS, PHOSPHOR BRONZE RODS (CHILL CAST and CONTINUOUS CAST), BRONZE INGOTS

TANDEM WORKS MERTON ABBEY LONDON SW19 Tel: Mitcham 2031 · ALUMINIUM WORKS WILLOW LANE MITCHAM SURREY Tel: Mitcham 2248



WHAT'S IN A TUBE?

At Chesterfield we can look back on over fifty years' experience in punching and drawing stubborn billets of steel into every shape and size of tube and hollow. This experience helps us to turn out impressive numbers of pressure vessels and gas bottles too. Whether you're on or off the beaten track, you are likely to come across the familiar shape* of a Chesterfield gas cylinder—one of over 9,000,000 already serving the needs of industry, medicine and construction the world over.

**Chesterfield gas cylinders are cold drawn, seamless and as perfect as our modern plant and manufacturing technique can make them. Chesterfield Cold Drawn Seamless Steel Gas Bottles are manufactured to conform to the specifications and regulations prescribed by the competent Authorities in all countries.*

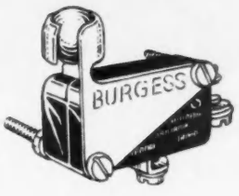
chesterfield tubes

THE CHESTERFIELD TUBE COMPANY LIMITED CHESTERFIELD ENGLAND · A TI COMPANY

CRC 61

O.K.—from any angle!

IT'S
Micro Switchcraft



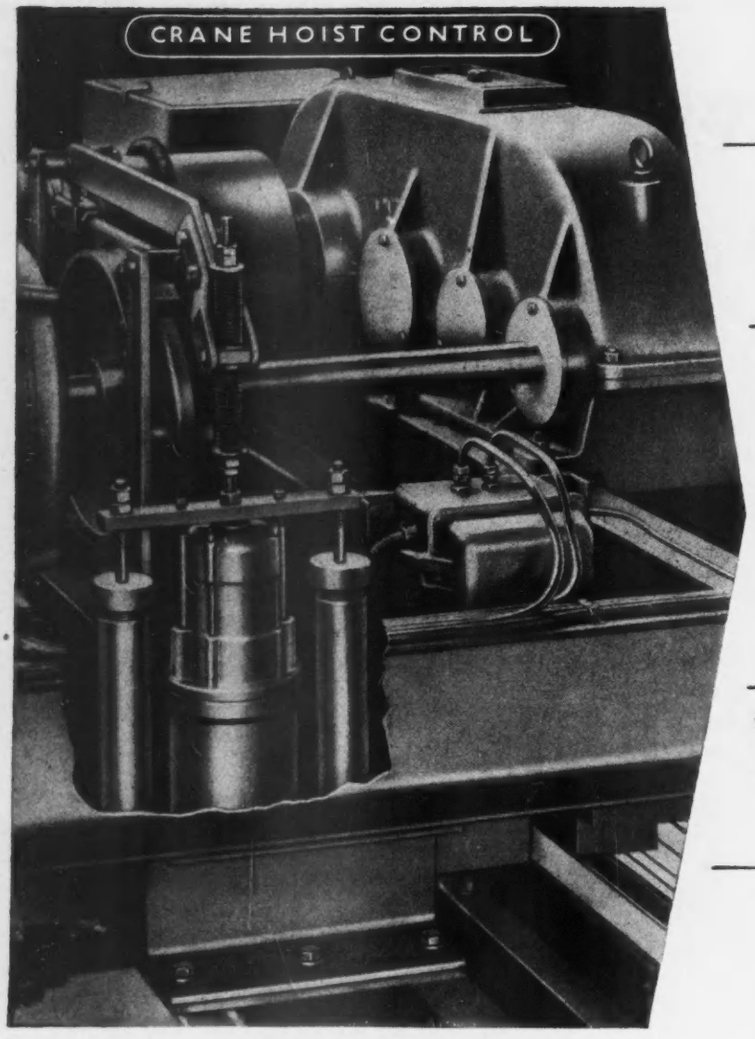
ACTUAL SIZE

THE BURGESS V3

Miniature Micro Switch with VAB Ball Actuator
will operate from any angle.

10 million operations minimum

BURGESS PRODUCTS CO. LTD, MICRO SWITCH DIVISION, DUKES WAY, TEAM VALLEY, GATESHEAD 11. Tel: Low Fell 75322. Telex: 53-229
127 Victoria Street, London SW1. Tel: Tate Gallery 0251 (3 lines)



Inching is eliminated by *Stacreep control

*** A thrustor-operated brake is used with a wound rotor induction motor to provide a stable creeping speed on load. The creeping feature is arranged to occur on the first one or two notches on a drum controller.**

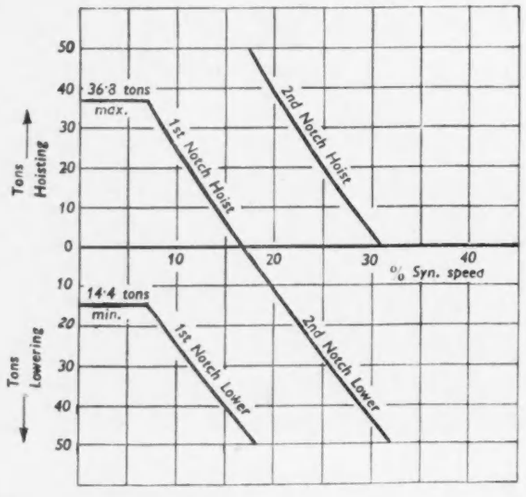
CREEPING PERIOD

1 Main motor is started ; thrustor motor which is energised from the main motor slip rings receives full line frequency and the thrustor lifts the brake.

2 Main motor accelerates but rotor frequency falls.

3 The speed of thrustor motor drops and the brake is gradually applied until Load Torque + Braking Torque = Motor Torque at a stable creep speed.

For further details, send for descriptive leaflets 12/4e-1



Creep speeds obtained at various loads.

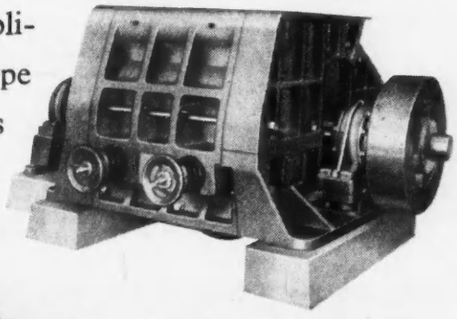
METROPOLITAN-VICKERS
ELECTRICAL CO LTD TRAFFORD PARK MANCHESTER, 17

An A.E.I. Company

J/T 701

On making an impact

THE ill-directed hammer wielded by an unskilled hand finds the thumb rather than the head of the nail. Very different are the well-directed hammers of the scientifically designed B.J-D FLEXTOOTH crusher; these hammers reduce industrial materials to required sizes by *controlled* impact. There are many other types of crusher in the B.J-D range, each giving optimum results on particular applications. Each type of machine is available in a variety of sizes.



B.J-D FLEXTOOTH CRUSHER

BJD

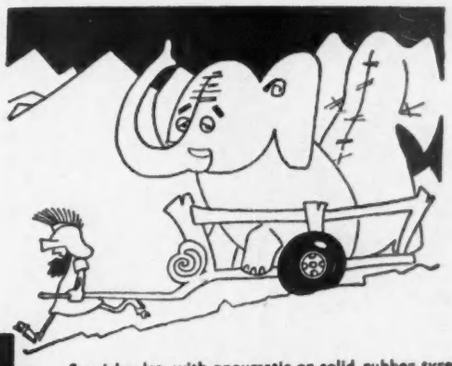
CRUSHERS

for most industrial applications

BRITISH JEFFREY-DIAMOND LIMITED,
CRUSHER AND INDUSTRIAL DIVISION, 15-17, CAXTON STREET LONDON, SW1

WF 5097

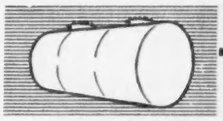
Hannibal would have been delighted with



R.B.P.

Special axles, with pneumatic or solid rubber tyre and wheel equipment, for all purposes or to specification.

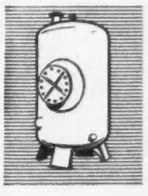
RUBBER BY-PRODUCTS (WARWICKSHIRE) LTD.
86, Holloway Head, Birmingham 1.
Tel: MIDland 3475 (5 lines)



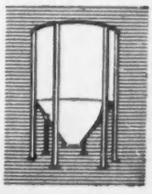
M.S.L
Electrically Welded

STORAGE & TRANSPORT TANKS

As supplied to all Ministries, Principal Oil Companies & Petrol Pump Manufacturers
For every storage and transport purpose. Steel Horizontal Tanks, Cylindrical Underground Tanks, Fuel Oil Tanks, Road Wagon Tanks, Rectangular Tanks, Air Receivers, Vats, Hoppers, etc.
When ordering specify M.S.L.



25 Years experience in Fabricated Arc-Welding Construction



Write for full particulars to :—
METAL STRUCTURES, LTD.
Angel Factory Colony, Angel Rd., Edmonton, N.18
Phone: Edmonton 6601/2/3 Grams: Metstru, Southtot, London.

UNUSUAL LIFTING BEAM

25 TONS S.W.L.

One of the many lifting devices from the BERL range, this unique lifting beam is equipped with twin shackles for connection to a ramshorn hook. Write for our leaflets now.

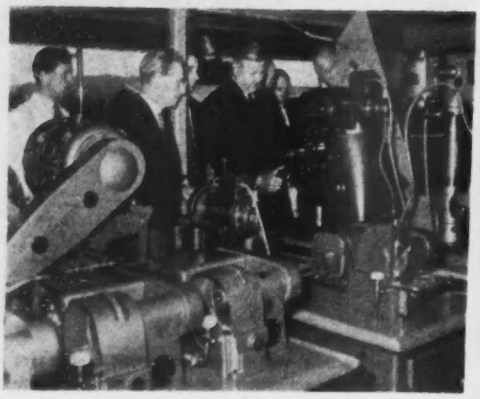
British Electrical Repairs Limited

Empire House, Charlotte Street, Manchester 1

BERL

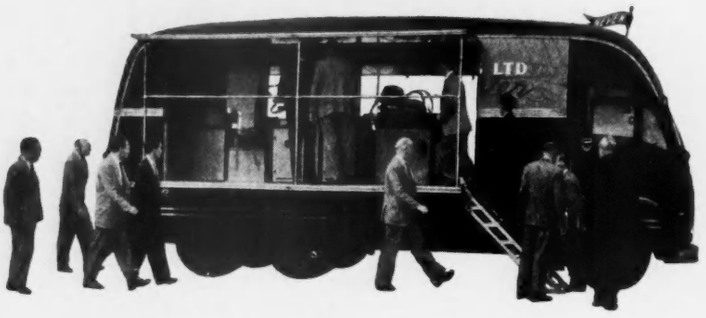
Better Equipment for Raising Loads

BER 89



a DEMONSTRATION?

IF YOU CUT, drill or grind glass, ceramics, carbide or any known hard material the Neven Mobile Unit will demonstrate the most efficient production methods with diamond tools. May we send this Demonstration Unit to your works? The Sales Manager would be pleased to advise you when the Unit will be in your area.



IDP

IMPREGNATED DIAMOND PRODUCTS LIMITED
OF GLOUCESTER · ENGLAND
TELEPHONE 21164 (3 LINES) TELEGRAMS IMPREG GLOUCESTER

NEWALL

★ *We shall be happy to supply any engineer designer who is interested with details of the various bolts and studs, which cover the full range of modern requirements.*

LOOK FOR THE NEWALL BRAND

BRANDED BOLTS

Each type of Newall bolt—

NEWALL HITENSILE
NEWALLOY
NEWALLASTIC
NEWALL HI-TEM

is branded with its own distinctive mark and is recognised by engineers as having "unique" qualities.

A. P. Newall & Co. Ltd.
POSSILPARK, GLASGOW, N.2.

Landmarks of the Future

New Chemical Building for Joseph Crosfield & Sons Ltd., Warrington. Photograph by courtesy of Matthew Hall & Co. Ltd., who were responsible for the design of this building.

This multi-storied building in structural steel will cater for the manufacture of chemical products based on silicates. The design makes provision for fork lift truck operation on all floors and incorporates a load bearing roof.

Steelwork for this landmark by :—

EDWARD WOOD & CO LTD

CONSTRUCTIONAL ENGINEERS

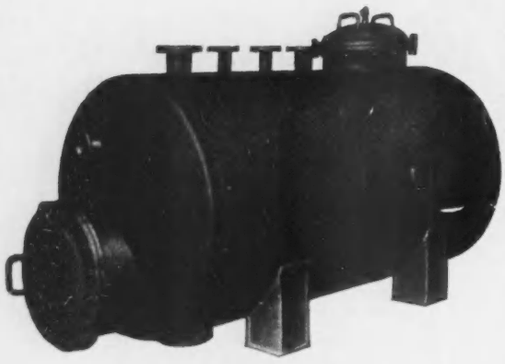
Registered Office and Works:
Telephone: TRAfford Park 2341 (10 lines)

OCEAN IRONWORKS · TRAFFORD PARK · MANCHESTER 17

London Office: 68 Victoria Street, S.W.1. Telephone: VICtoria 1331/2.
Technical Offices at Birmingham and Nottingham

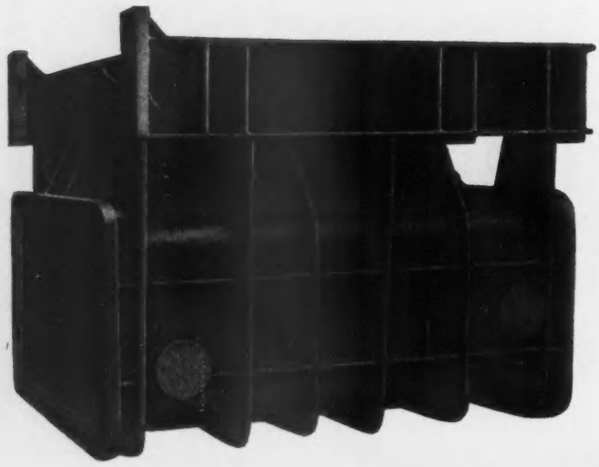
dmWD88

Fabricated Platework to your specification



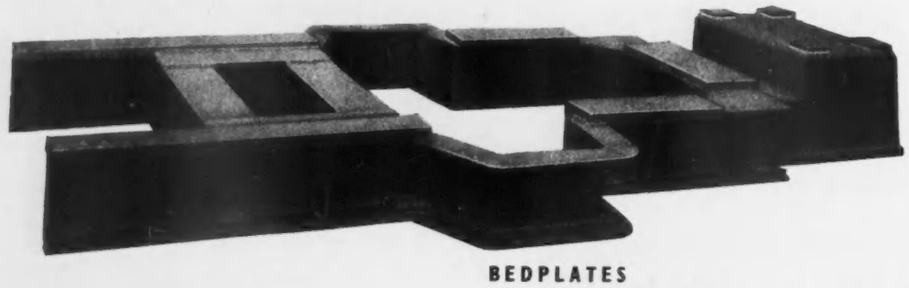
VESSELS

We manufacture a large variety of Vessels in Mild Steel or Aluminium Alloys, for all purposes. Vessels with special linings can also be supplied either homogeneous lead or rubber-lined. Mechanical stirrers or paddles can be incorporated to customers' requirements.



SPECIAL FABRICATIONS

Intricate shapes such as Condenser Cases are the outcome of our many years' fabrication experience and by producing clean finished parts requiring no machining, we can supply a structure with clean lines and minimum distortion.



BEDPLATES

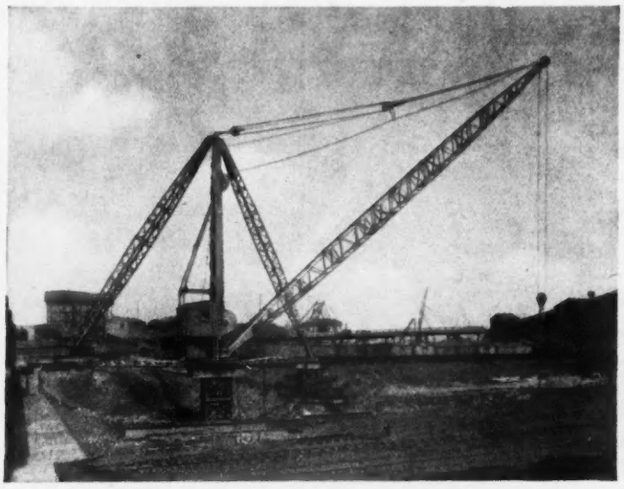
We can supply Bedplates for machinery, fabricated to all types of designs. Such structures are free from distortion, rigid and indestructible, and show a great saving in weight over other types. All necessary machining can also be carried out.

Our latest Brochure "FABRICATED PLATEWORK" fully describes our activities in this field. A copy is yours on request.

ALLENS of TIPTON

W. G. ALLEN & SONS (TIPTON) LTD · P.O. BOX 4 · TIPTON · STAFFORDSHIRE.

TEL: TIPTON 1266



15-ton 120 ft. Jib Electric Derrick on Steelworks Erection

ANDERSON

the finest

DERRICK CRANES

One Derrick Crane may look the same as another—*from a distance.* At close quarters the differences are astounding. The cabin interior, alone, clearly establishes ANDERSON design and construction to be supreme. The clean, compact gearing, built on unique unit principles, guarantees mechanical efficiency and reliability—and ensures lowest erection and operating costs. The driver's panoramic visibility, centralised easy control and comfort *have to be seen to be believed.* High performance and safety are spontaneous—a banksman often superfluous. These and other exclusive features explain why independent examiners are so impressed, and more and more users specify ANDERSON only.

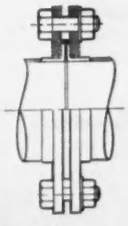
ALSO LEADING MAKERS OF ELECTRIC OVERHEAD TRAVELLING CRANES

TELEPHONE:
CARNOUSTIE 2214/5
TELEGRAMS:
"DIAMOND" CARNOUSTIE

ANDERSON

THE ANDERSON-GRICE CO. LTD.
TAYMOUTH ENGINEERING WORKS, CARNOUSTIE, SCOTLAND

LONDON OFFICE:
FINSBURY PAVEMENT HOUSE,
120, MOORGATE, E.C.2.
TELEPHONE: MONarch 4629



Here's an entirely new conception of piping —a comprehensive range of standard units, in four bore sizes (3″, 4″, 6″ and 8″) plus reducers that can be assembled, dismantled and re-assembled time and time again by comparatively unskilled labour. Swept bends and a unique system of gasket jointing eliminate all bacteria harbouring crevices and ensure an uninterrupted flow, free from blockages of any kind. Standard straights, bends, tees and reducers permit a wide variety of applications, while further units can always be purchased for expansion or variation.

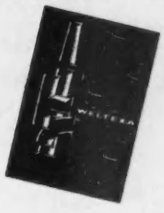
LET

WELTEXA

SHAPE YOUR FUTURE

STANDARD UNIT LIGHT-WALL
STAINLESS STEEL PIPING

Interested ? Then send for our technical booklet "The WELTEXA System," today.



WELDING TECHNICAL SERVICES LTD. (DEPT. D), HURST MILL, KINGS NORTON, BIRMINGHAM 30

THE ENGINEER

BUYERS GUIDE

1959

Now Available

CONTENTS

Forthcoming Engineering & Industrial Exhibitions.

Associations, Institutions and Societies connected with the Engineering Industry.

National Undertakings.

Address Section.

U.K. Agents for Foreign Firms. Trade Names.

Buyers Guide.
33,500 Suppliers' entries under 2,500 product headings.

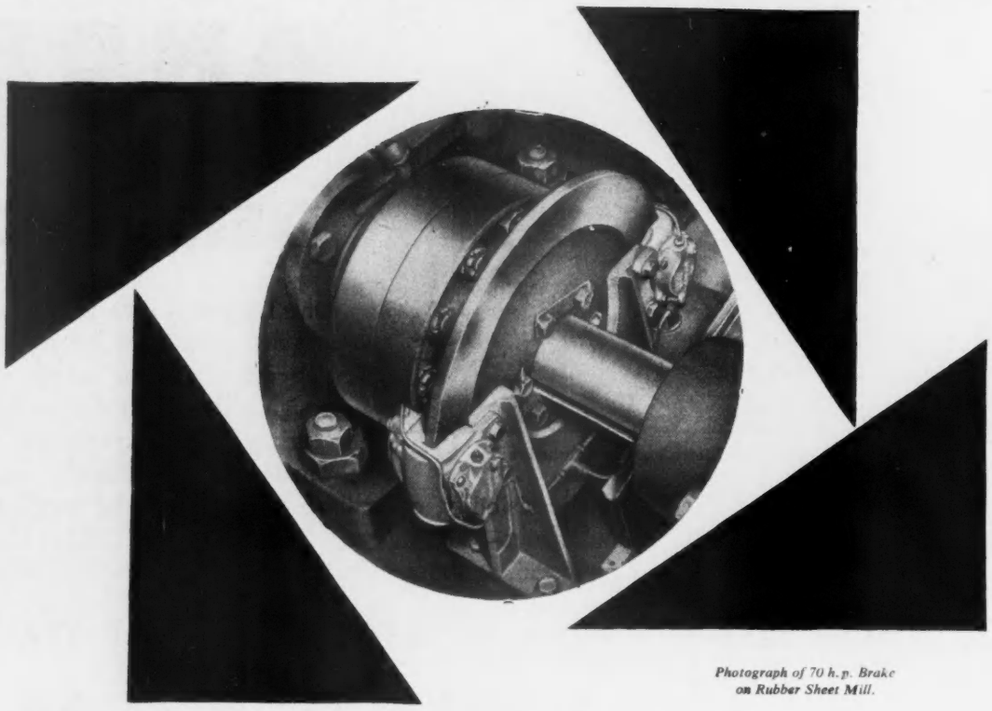
One free copy has been sent to every postal subscriber to 'THE ENGINEER' and every regular reader who buys his copy from a newsagent.

A copy has also been sent to each advertiser in 'THE ENGINEER' and the BUYERS GUIDE itself.

Additional copies obtainable at 7/6 each (plus postage 1/9) from :—

The Manager—
THE ENGINEER
28, ESSEX STREET, STRAND,
LONDON, W.C.2
CENtral 6565

TWIFLEX INDUSTRIAL DISC BRAKES



Photograph of 70 h.p. Brake on Rubber Sheet Mill.

for really effective braking power

THE TWIFLEX DISC BRAKE EMPLOYS DUNLOP OPERATING UNITS BASED ON THOSE WHICH HAVE REVOLUTIONISED AIRCRAFT AND VEHICLE BRAKING.

For all Industrial and Marine Braking Problems TWIFLEX Disc Brakes Provide:

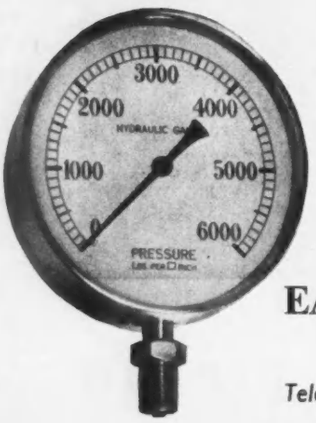
★ Consistent Braking under all conditions.
★ Complete absence of "Brake Fade."
★ Increased stopping power.
★ Automatic adjustment for wear.
★ Long life, reliability and ease of maintenance.

For further information or for details of the well known range of TWIFLEX Flexible Couplings—write to :—

TWIFLEX COUPLINGS LIMITED
The Green · Twickenham · Middlesex. (One of the Sheepbridge Engineering Group).
Telephone: POPesgrove 2206/9 · Telegrams: Twiflex · Twickenham.

PRESSURE GAUGES..

OF EVERY DESCRIPTION AND SIZE



PRESSURE RANGE FROM
5 - 20,000 lbs per sq. inch

Prompt Deliveries
Highest Quality

Send For Illustrated Catalogue

EAGLE & WRIGHTS (GAUGES) LTD.
87 CARVER STREET
Telephone: Central 8196 BIRMINGHAM, 1

An Exhibition in itself....

one of WARD'S MACHINERY SHOWROOMS AT SHEFFIELD

Others at : SILVERTOWN (LONDON) · GLASGOW · BRITON FERRY

VISITORS ARE ALWAYS WELCOME AND REMEMBER — WARDS MIGHT HAVE IT !

THOS. W. WARD LTD

ALBION WORKS · SHEFFIELD
'PHONE 26311 (22 lines). 'GRAMS 'FORWARD SHEFFIELD'
LONDON OFFICE: BRETTENHAM HOUSE
LANCASTER PL. STRAND W.C.2, 'PHONE TEM 1515

G.56

Riding the tide with Birmabright

This 50′ × 20′ × 4′ 6″ Birmabright launch pontoon, together with gangway, was designed and constructed by Whittingham & Mitchel Ltd. to the order of John Mowlem & Co. Ltd. on behalf of the Esso Petroleum Company Ltd., and is here shown in service at their Fawley refinery.

Birmabright aluminium alloy is the ideal choice of material for this equipment—and indeed wherever a minimum of maintenance is desirable—since its excellent corrosion resistance makes protective painting unnecessary.

Why not write now for further information?

Birmabright

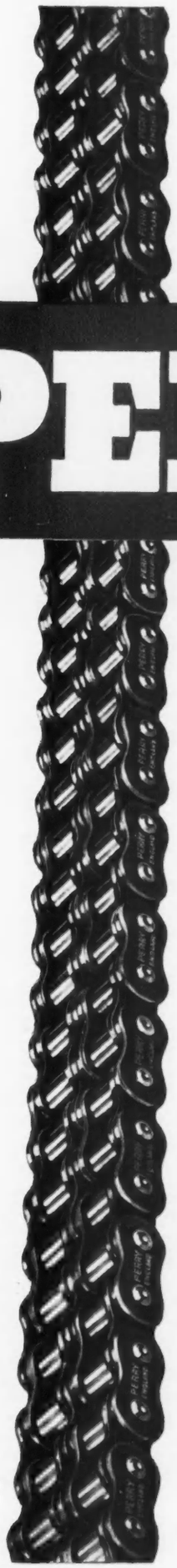
Registered Trade Mark

The Pioneer Aluminium-Magnesium Alloy

BIRMABRIGHT LIMITED · WOODGATE WORKS · BIRMINGHAM 32

BM 226

Marine Department: Westmorland House, 127 Regent Street, W.1. Telephone: Regent 4772



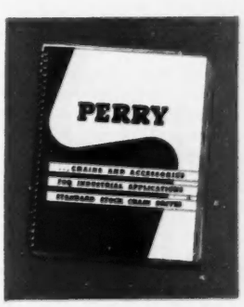
PERRY

Chain Makers to Industry for over 70 years

If you have a Chain Drive problem - let PERRY solve it for you. Over 70 years' specialised experience ensures that, today, PERRY Chains and Chain Drives are available for every industrial application. Write now for your free copy of the comprehensive and fully illustrated PERRY Handbook.

PERRY CHAIN COMPANY LTD.
TYSELEY, BIRMINGHAM 11.

(A Division of the Perry Group)



P.I./33

Have you a thickness measuring problem?

Compact and easy to use, the Elcometer provides a simple economic method of measurement from one side without damage to surfaces. It gives split-second thickness readings of all non-magnetic coatings on ferrous bases with an accuracy of ±5% ±·0001 in. Non-ferrous foils, sheetings, etc., can also be measured if laid on a ferrous base. The Elcometer, now in a newly designed unbreakable case, is available in a wide range of models, including versions for gauging Ferrite percentage content of stainless steels and graphitic corrosion penetration in cast iron.

THE ELCO METER

THICKNESS GAUGE

MEASURES :—
Coats of Paint.
Vitreous Enamel.
Tobacco Leaves.
Plastic Coating or Sheets.
Fibreglass Hulls and Bodies.
Non-ferrous Films of all kinds.

For further information, send coupon for free booklet. You are also invited to seek advice from our technical experts.

To East Lancashire Chemical Co., Ltd., Fairfield, 1, Manchester.

Please send me copies of booklets "The Elcometer Thickness Gauge," and "The Elcotector."

NAME.....

ADDRESS.....

.....

COUNTY.....

Have you heard about the new **Elcotector,** *which :—*

Measures—
Metallic coatings on metallic bases.
Non-metallic coatings on metallic bases.
Metallic coatings on non-metallic bases.

Compares—
Hardness of steel.
Grades of alloys.
Grades of steel.

Locates—
Surface cracks in metals.

SAVE TIME AND MONEY with I.C.I. products and the CO_2/Silicate Process

LOWER—fuel costs
handling and transport costs

FEWER—moulding boxes
core irons, lifters, and sprigs
blow holes
noxious fumes

NO—core carriers

GREATER—output per unit area of working space, precision in manufacture

I.C.I. products for the Foundry

CARBON DIOXIDE

'Drikold' and the 'Drikold' Liquefier
—for the small foundry
I.C.I. Liquid Carbon Dioxide in Bulk and the 5-ton capacity storage tank
—for the large foundry

SODIUM SILICATE

Grades C.112 and C.125
—supplied in 10-gallon or 45-gallon drums, and in road or rail tank vehicles

ISOPROPYL ALCOHOL

Refined Isopropyl Alcohol 'Imsol' A
—supplied in 40/45-gallon drums, and in road or rail tank vehicles

Full information on request.

IMPERIAL CHEMICAL INDUSTRIES LTD., MILLBANK, LONDON, S.W.1

DK.288A

1,450

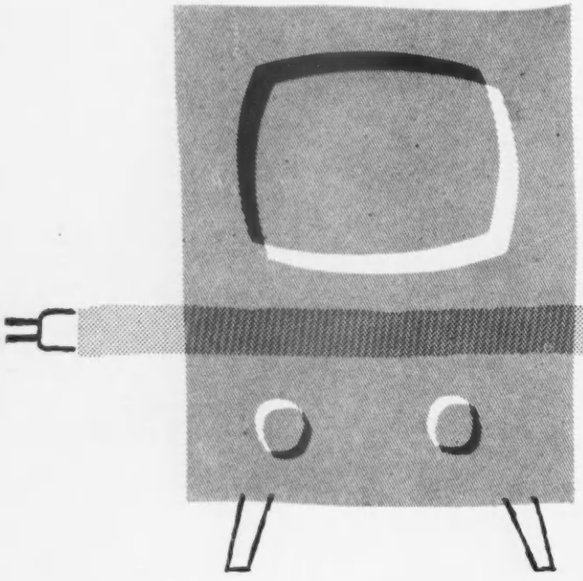
more units with ONE SPEEDICUT TAP

Our customer produces Iron Pipe fittings. Normal tap life when machine tapping was only 40/50 components. A Technical Representative from Speedicut Works studied the problem and made recommendations on design and treatment which increased tap life on this operation to over 1500 components.

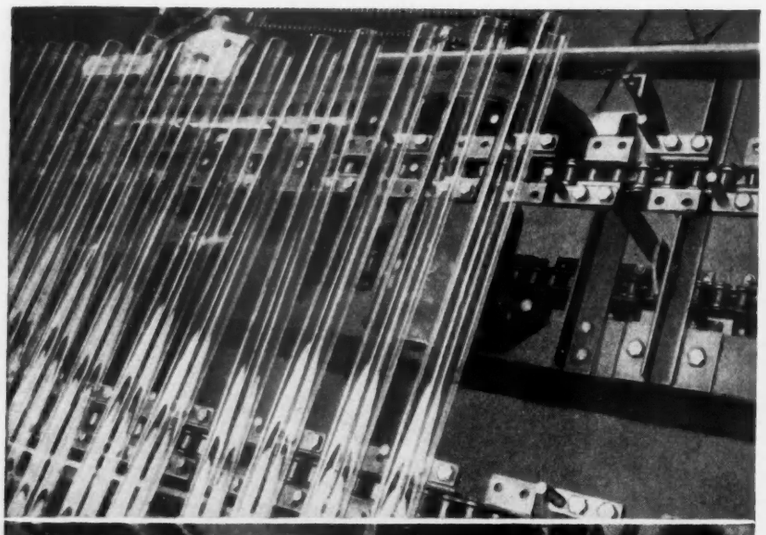
Take advantage of the latest techniques in tool making—SPECIFY SPEEDICUT.

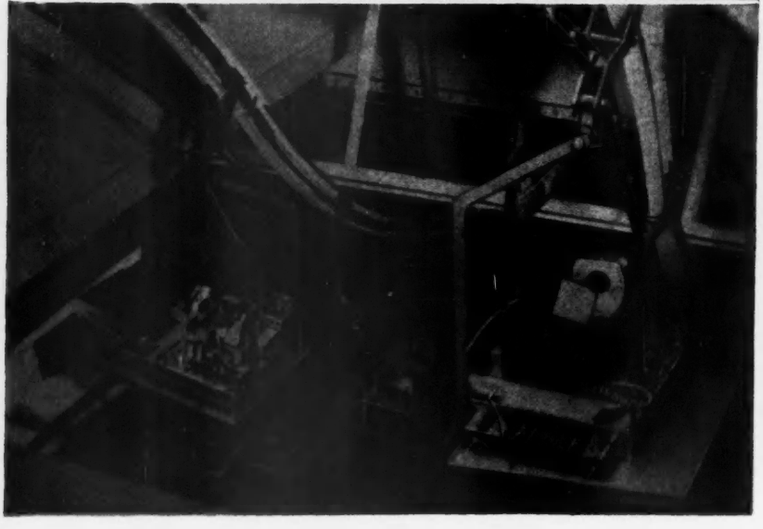
F. B. T. FIRTH BROWN TOOLS LTD.

SPEEDICUT WORKS . CARLISLE STREET EAST . SHEFFIELD



from Lamps to Television Sets





Whatever the product to be moved — up, down, or around — a Renold Chain is there to do the job.

With their all-steel construction, accuracy of manufacture, and high ratio of strength to weight, they are the hallmark of a first class conveyor installation. These features mean least power consumption for the load moved, and the avoidance of excessive weight in conveyor structures.

RENOLD

Chains for mechanical handling

RENOLD CHAINS LIMITED · MANCHESTER

RENOLD

— the FIRST name in precision chain

Vital in every Industry-

CYCLONE

fans, air conditioning and ventilating equipment

Most of the ***big names*** *have installed Cyclone Fans and Equipment. Cyclone Air Conditioning and Ventilating Equipment is an essential ingredient in ensuring product purity and maximum output efficiency.*

We will gladly forward literature detailing our full range of equipment or give specialist advice.

MATTHEWS & YATES LTD.

CYCLONE WORKS · SWINTON (MANCHESTER) & 135 RYE LANE, PECKHAM, LONDON S.E.15

TELEPHONE: SWINTON 2273 (4 lines) TELEPHONE: NEW CROSS 6571 (4 lines)

Also at: Glasgow · Leeds · Birmingham · Cardiff · Bournemouth

MoS_2 IN AN AEROSOL SPRAY

ROCOL 'ANTI-SCUFFING' SPRAY

applies the new

MOLYBDENUM DISULPHIDE

dry lubricant

This speedy, convenient method of application is invaluable for 'on the spot' attention, where parts cannot be segregated for special treatment. Strongly recommended to Service and Maintenance Engineers, Machine and Plant Operators, this method of application is ideally suited for assembly and replenishment of dry lubricating films. Excellent for use on engines, open bearings and chains working in extreme temperatures; on slides, runways, moulds, dies and all press working tools.

THE AEROSOL PACK
of 12 oz. capacity is available now

(Single packs 25/- each; 3 doz. packs—24/- each; 1 gross—23/- each). Full instructions for use are printed on each pack.

A Rocol PRODUCT

Write for descriptive leaflet to—

ROCOL LIMITED

IBEX HOUSE · MINORIES · LONDON E.C.3 · 'PHONE ROYAL 4372 · ROCOL HOUSE · SWILLINGTON · LEEDS · 'PHONE GARFORTH 2261/2

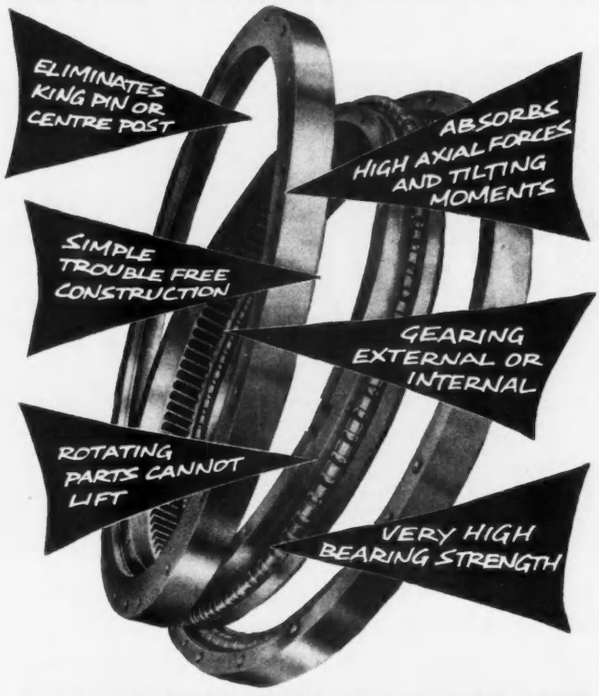
ndh 11147A

Move in the best of circles with

Roballo

NOW BRITISH MADE!

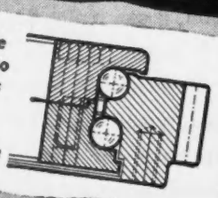
LARGE BALL BEARING SLEWING RINGS


ELIMINATES KING PIN OR CENTRE POST
ABSORBS HIGH AXIAL FORCES AND TILTING MOMENTS
SIMPLE TROUBLE FREE CONSTRUCTION
GEARING EXTERNAL OR INTERNAL
ROTATING PARTS CANNOT LIFT
VERY HIGH BEARING STRENGTH

ALSO ROBALLO WIRE RACE BALL BEARING RINGS

For fast, continuous and accurate rotation.

Bearings can be manufactured to each customer's requirements at a highly competitive price



Literature and technical advice is yours for the asking.

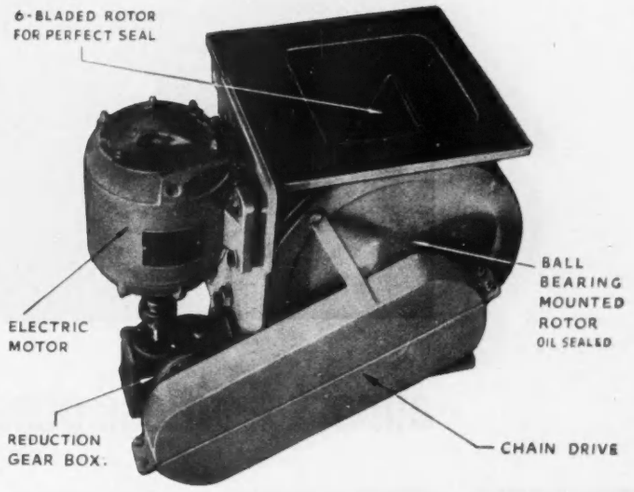
ROBALLO ENGINEERING CO. LTD.

43 Dover Street, London W.1.

Telephone: HYDe Park 0659

THE ROTARY VALVE

OR FEEDER FOR CYCLONES AND BINS



REDUCES DUST LOSSE

CAPACITIES UP TO 70 TONS PER HOUR

ELIMINATES FIRE RISK

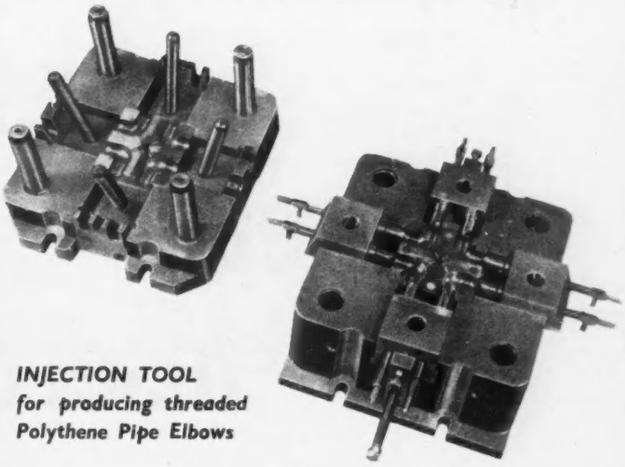
TRADE SUPPLIED

WRITE FOR LEAFLET

F. E. CALLOW
(ENGINEERS) LIMITED
BIRCHILL RD., KIRKBY TRADING ESTATE
LIVERPOOL · ENGLAND

Telephone: Simonswood 2461-2

Moulding Tools by Specialists



INJECTION TOOL for producing threaded Polythene Pipe Elbows

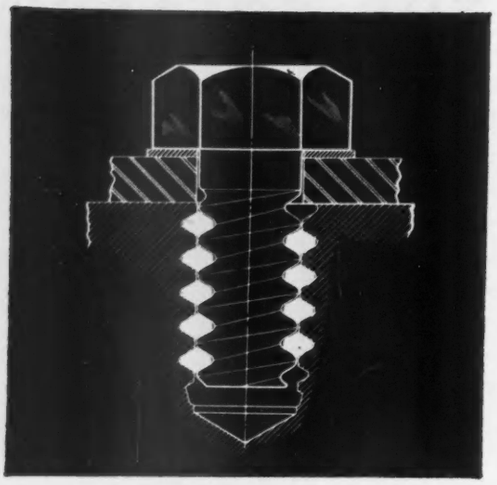
H. B. SALE LTD

PROGRESS WORKS, SUMMER LANE, BIRMINGHAM

Telephone: CEN 5661/3 Grams: SALE, BIRMINGHAM

Established 1862

MEMBER



almost limitless possibilities of saving in time and cost

HELI-COIL*

screw thread inserts

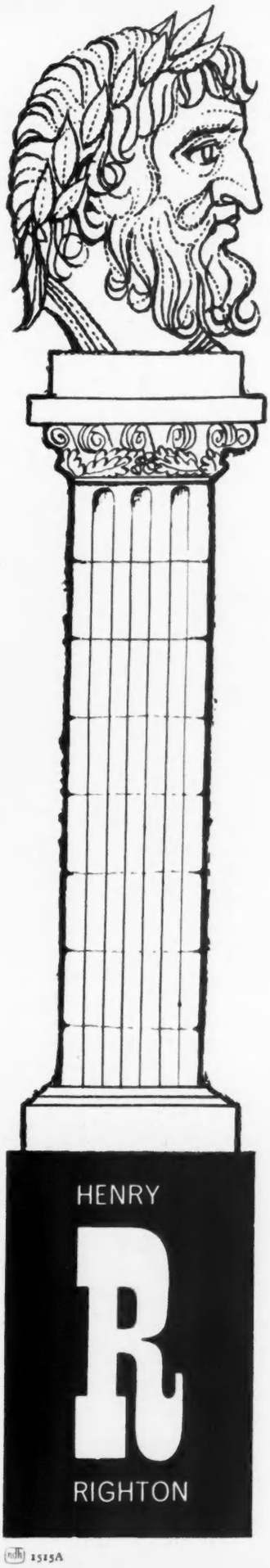
Heli-Coil Inserts are self-anchoring thread liners made from high tensile stainless steel wire. In tapped holes they provide a conventional thread with higher loading strengths and greater resistance to wear and stresses than unprotected threads. The Heli-Coil eliminates stripping, seizing, galling and corrosion. It literally *armours* the thread. The Heli-Coil offers a unique opportunity for product cost revision. It is "a natural" for automation, it can make dramatic cuts in time and labour costs. Assembly is the ultimate in simplicity — just drill, tap and install. The Heli-Coil saves weight and space. It improves the serviceability and appearance of the end product. We suggest you write soon for data on Heli-Coil, the British-made Insert that is available internationally. It is a product of the day and this atomic age.

For further details write for Sales leaflet APL.48/E.5

ARMSTRONG PATENTS CO. LTD. EASTGATE, BEVERLEY, YORKSHIRE

Tel.: Beverley 82212

* *HELI-COIL is a registered trade mark*



The wiser way

OF BUYING SEMI-FABRICATED NON-FERROUS METALS

is to buy from stock at the time the materials are actually required, thereby avoiding the risk of purchasing either too much or too little material for the contract concerned. Until recently, buyers of NON-FERROUS METALS have been compelled to place a good proportion of their orders direct with the Works on a forward delivery schedule, in order to obtain the materials at basic prices and avoid a stockholding premium. NOW however, we at RIGHTON are in a position to offer material for IMMEDIATE DELIVERY at MILL PRICES *for all quantities*. We would also point out that as Official Stockholders for I.C.I. (Metals Division) all of our stocks within the range they produce are of their manufacture. This ensures a high consistency of quality and temper so often lacking when purchasing from stockholding sources. THE RIGHTON SERVICE is at *your* disposal—why not pick up the telephone and use it NOW?

Henry Righton
& CO. LTD

70/84, PENTONVILLE ROAD, LONDON, N.1

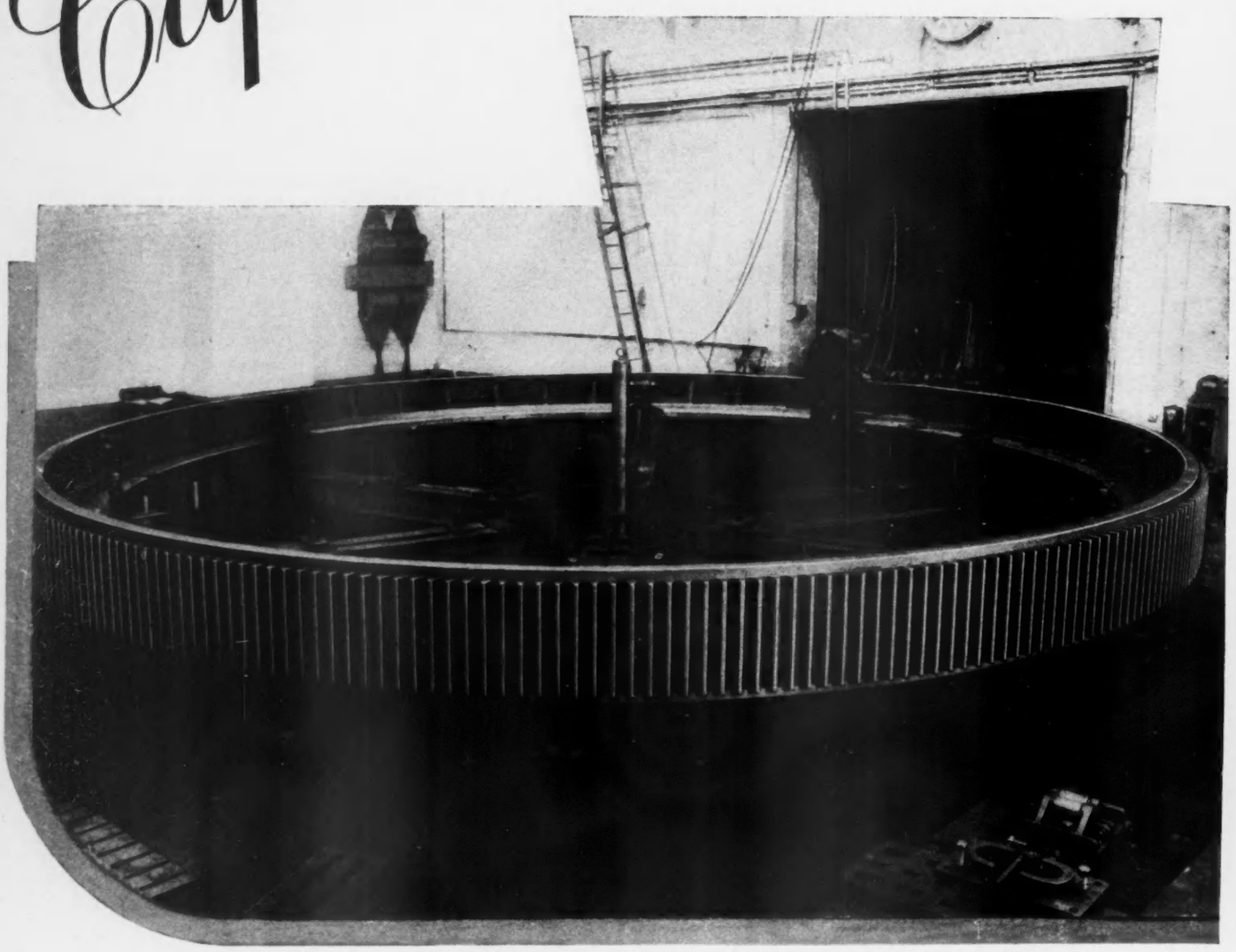
TELEPHONE TERMINUS 8877

AND AT BIRMINGHAM & BRISTOL

1515A

Capacity!

Our unique steel foundry and machine shops are specially equipped for the production of Spur, Helical or Bevel Gears, either machine cut or machine moulded, of the largest sizes. 'Jackson' gears are in constant world-wide use in all heavy industries — why not consult us and take advantage of over a century's technical experience.



Cutting 26ft. Dia. spur ring on 30ft. machine.

THE
DAVID BROWN
CORPORATION (SALES) LIMITED
JACKSON DIVISION
SALFORD WORKS HAMPSON STREET
MANCHESTER 5

HYDRAULIC PRESSINGS AND ROLLED RINGS

by

Caston Barber

HYDRAULIC PRESSINGS

Producing Hemispherical ends and other hydraulic pressings of up to 3 feet in diameter, Caston Barber have a wide range of existing tools, a list of which will gladly be sent on request. Dished and Flanged cylinder ends, with or without inspection openings, are also manufactured to order.

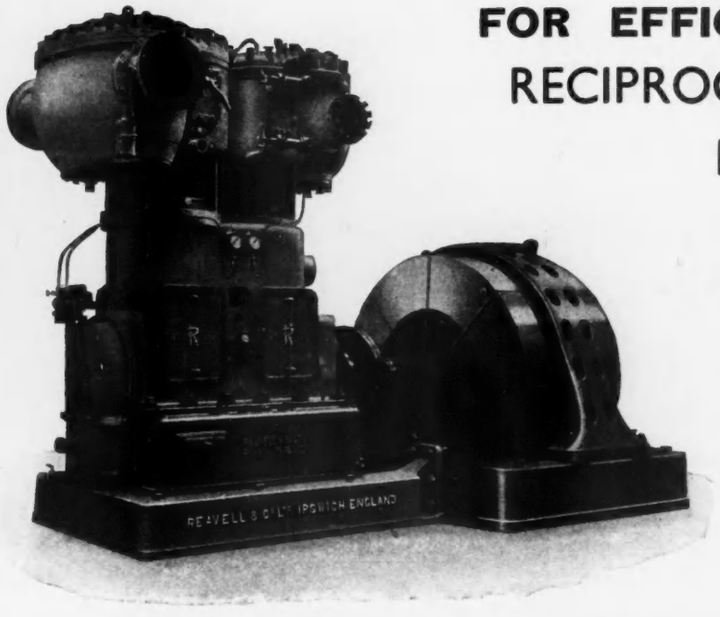
ROLLED RINGS

Caston Barber produce rings from a wide range of flat and angled sections of mild or stainless steel. Flanged rings and washers are supplied to meet all specifications and in many cases the rings are flash butt welded.
Caston Barber have the equipment and the experience to meet your requirements.

Do not hesitate to write or telephone your enquiries to :

CASTON BARBER, 47 TABARD STREET, LONDON, S.E.1 Telephone: HOP 1991/5

SPECIFY **"REAVELL"**



FOR EFFICIENCY AND RELIABILITY

RECIPROCATING COMPRESSORS

ROTARY COMPRESSORS

TURBO COMPRESSORS

PRESSURES FROM

1 TO 10,000

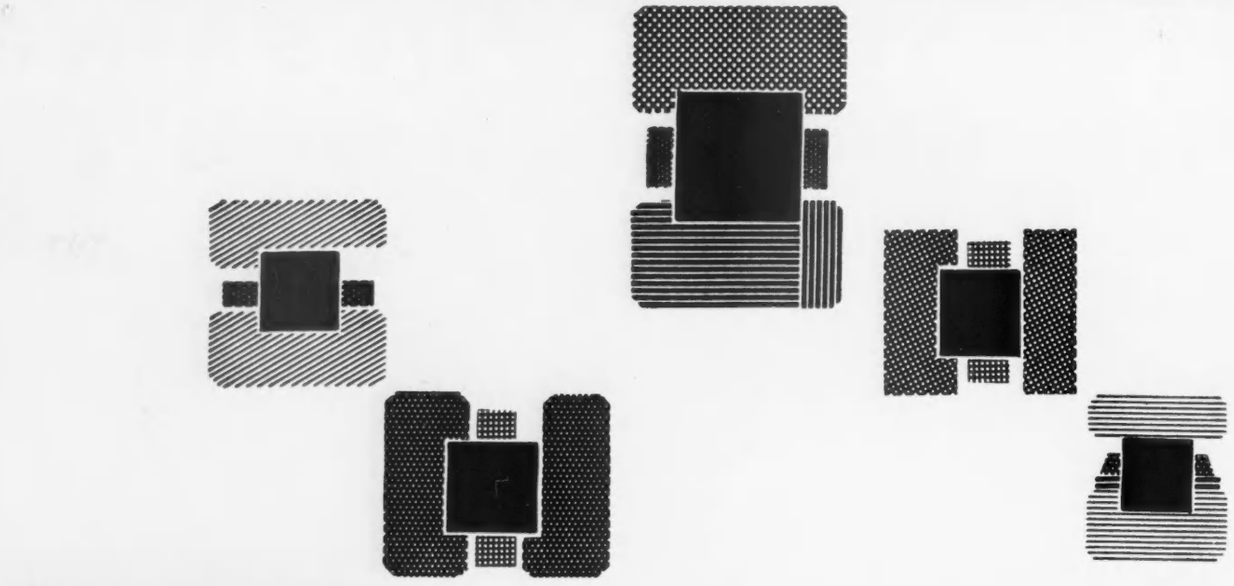
LBS. PER SQ. INCH

FOR AIR, HYDROGEN, OXYGEN, NITROGEN, AND OTHER GASES.

REAVELL & COMPANY LIMITED

IPSWICH, ENGLAND

Telegrams: "REAVELL" Ipswich **Telephone: Ipswich 56124 (3 lines).**



R & M

R & M PARALLEL ROLLER BEARINGS...

one of the basic types from a range of ball and parallel roller bearings designed to meet every speed, load and application.

R & M PARALLEL ROLLER BEARINGS BRING YOU THESE BENEFITS

- **They will carry heavy journal loads.**
- **Their construction can provide compensation for shaft expansion or contraction either axially or radially.**
- **Varying lip arrangements can ease assembly difficulties.**
- **Can often provide a solution to trouble from shock loads or vibration.**

Have you a copy of our Publication 37? Full technical details of Parallel Roller Bearings will be found on pages 102 and 103.

BALL & ROLLER R&M BEARINGS

RANSOME AND MARLES BEARING COMPANY LTD.

NEWARK-ON-TRENT • TELEPHONE 456 • TELEX 37-306

BRANCHES • OFFICES AND AGENCIES THROUGHOUT THE WORLD

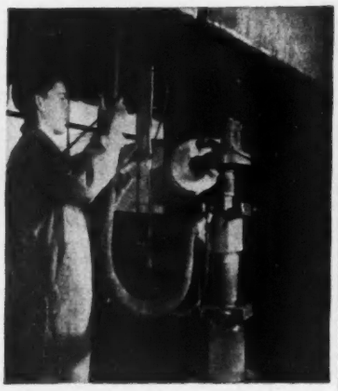
Call for an investigation

If a percentage of raw material or end product is lost in dust—if dust is a danger or just a nuisance—then call for an investigation on site by Mancuna. The Mancuna Test Method outlined in these photographs determines the basic collection problems on the spot—under the actual conditions of grain loading, particle size, temperature, humidity and agglomeration, with which the collection plant will have to contend.

Given this exact knowledge and with the high efficiency Mancuna-Dustex collector to back their findings, Mancuna technicians can give you an accurate forecast of results and costs on which to base your decision. If Mancuna equipment is not suitable, we will be the first to tell you and suggest alternative methods.

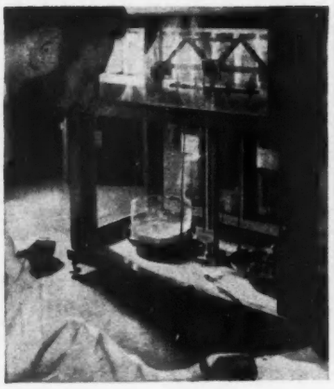
A leaflet describing the procedure in detail is available on request.

Stage 1
A pitot tube reading is taken to determine gas velocities in the conveying duct.



Stage 2
The single standard miniature cyclone Tube Test assembly. A test is run under operation conditions.

Stage 3
Laboratory analysis shows particle size and other characteristics of samples collected.



Stage 4
Knowing weight of catch sample, and time run on test, Mancuna can determine dust load and percentage of dust recoverable.

Consult

MANCUNA ENGINEERING LIMITED

DENTON, MANCHESTER. Tel. : DENton 3965 (5 lines).

London Office : 59, VICTORIA ROAD, SURBITION, SURREY.
Telephone : Elmbridge 9793.

Specialists in gas cleaning and dust technology.

CASTINGS

HIGH QUALITY ENGINEERING & MACHINE TOOL CASTINGS

HEAT & WEAR RESISTING UP TO 10 TONS also in SPHEROIDAL GRAPHITE IRON & STEEL

MACHINING

R. GOODWIN & SONS (ENGINEERS) LTD.
IVY HOUSE FOUNDRY, HANLEY, STOKE-ON-TRENT Phone: Stoke-on-Trent 23612

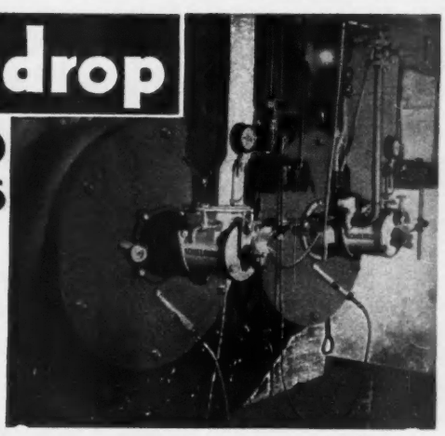
Schieldrop

OIL FIRED BOILERS

We Guarantee

13½ to 14 per cent CO_2 with Shell Smoke number 4 or less.

Write for Catalogue quoting Reference A/11



Schieldrop & CO.LTD
STOTFOLD, BEDS. Tel. 414 (4 lines) **OFFICES AT : BIRMINGHAM · LONDON · MANCHESTER SWANSEA · GLASGOW** BMJ

Mechanised Handling

This kind of plant is almost as beneficial to your customers as it is to you. They can be sure you are delivering to specification and with greater speed. Lorries are loaded in a matter of seconds and kept on the road. You save your own time as well as theirs and the quality of the product is mechanically assured. This type of plant can be designed and adapted to your needs, whilst allowing for any special conditions of site or working.

NIAGARA
SCREENS (Gt. Britain) LTD.

STRAYSFIELD ROAD, CLAY HILL,
ENFIELD, MIDDLESEX.

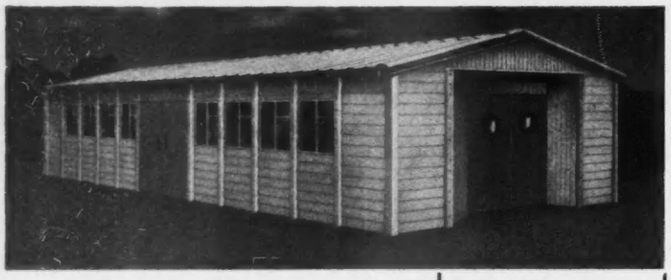
Telephone: ENField 6622 (4 lines)

Sole manufacturers of
"TENEMAX"
Regd. TRADE MARK
PIANO WIRE SCREENING SURFACES
The solution to damp and difficult materials.
No heating required.
Fullest particulars on request.

PLANNED DISMANTLING
REMOVAL ERECTION
INSTALLATION AND
MAINTENANCE OF
MACHINERY AND PLANT

MACHINERY INSTALLATIONS LIMITED
60A HIGH STREET ACTON LONDON W.3 Telephone: ACORN 6044 P.B.E.
Also at
BIRMINGHAM MIDLAND 5731 P.B.E. · CARDIFF 25471 · GLASGOW CITY 6597 · NEWCASTLE-UPON-TYNE 22336

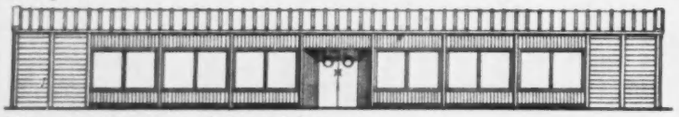
BANBURY
present a brilliant new range of all-purpose concrete buildings.



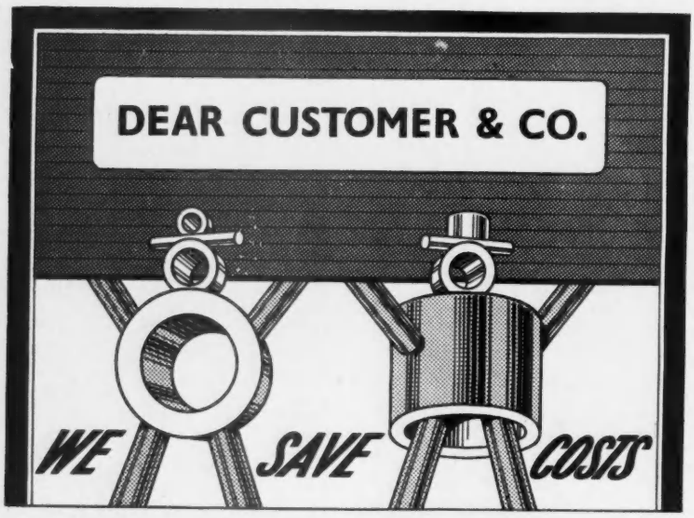
Here's the portable yet permanent answer to your building problem.
Banbury industrial buildings are only one-third the cost of brick and can be erected in a quarter the normal time.
Banbury can give you a complete planning, siting and erection service. Wide choice of main doors, porticos, shop fronts, windows, etc. Doors and windows can be placed wherever YOU like. Your building can be as long as you like or as small as you like.

You can build these and many others at a basic price of only
7/11 per sq. ft.
Warehouse Canteen
Factory Shop
Village Hall Farm Building
Cafe Workshop

Below is a showroom we've just designed for a large Midlands firm. It shows how adaptable Banbury Buildings are.



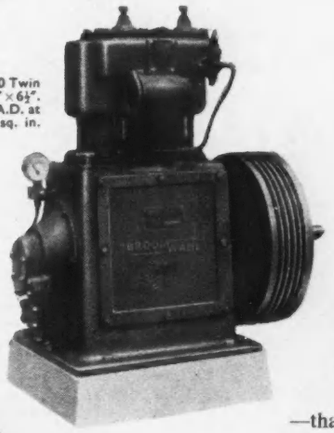
Write for brochure to Industrial Division,
PORTABLE CONCRETE BUILDINGS, LTD.
IRONSTONE WORKS, AYNHO ROAD, ADDERBURY WEST, Nr BANBURY, OXON
DHB/7988



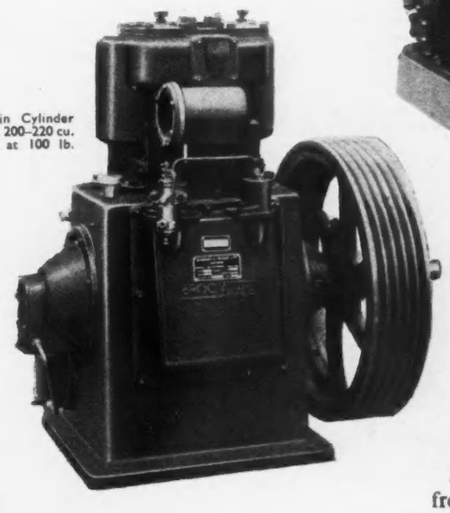
Seamless Steel Tubes for Machining
OPEN ALSO YOUR DOORS FOR SAVING TIME—MATERIALS—LABOUR
THEY ARE AVAILABLE IN MANY SIZES TO SUIT YOU
Please send enquiries to:
BRITISH & GENERAL TUBE Co. LTD.,
TRADING ESTATE · SLOUGH, BUCKS.
Phone: SLOUGH 24171 (5 lines) Telex: 84100 TUBECO, SLOUGH
Grams: TUBECO, SLOUGH, TELEX
Suppliers also of Welded and Seamless Tubes for Gas, Water and Steam, Boiler Tubes, Cold Drawn Seamless and Electrically Welded Precision Steel Tubes.

For RELIABILITY your choice should be "BROOMWADE"

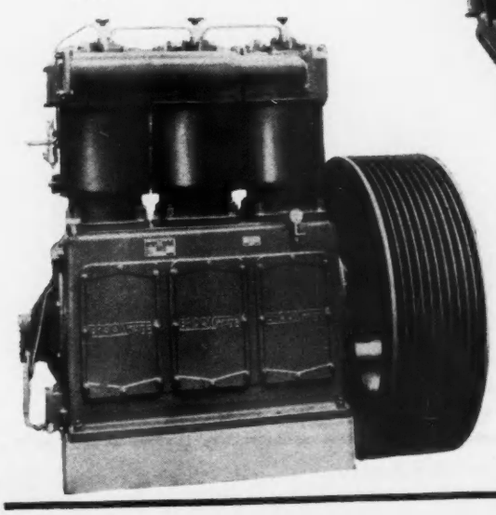
- Simple design
- Slow speeds
- Adequate cooling
- High performance
- Low initial cost
- Low maintenance cost
- Proved long life



EP 660 Twin Cylinder 6" × 6½". 100 cu. ft. F.A.D. at 100 lb. per sq. in.



D 23 Twin Cylinder 8¼" × 10". 200–220 cu. ft. F.A.D. at 100 lb. per sq. in.



EH 255 Three Cylinder 11¼" × 12". 600 cu. ft. F.A.D. at 100 lb. per sq. in.

RELIABILITY

—that is the foundation upon which "BROOMWADE" has built up an enviable, world-wide reputation. But "BROOMWADE" does not rest on its laurels. By constant research and development, efficiencies are improved and machines kept abreast of any competitive design. You can rest assured that "BROOMWADE" will give you EFFICIENT and TROUBLEFREE service—that is the opinion of an ever increasing number of users.

A wide range is available; outputs varying from 2 c.f.m. to 2,200 c.f.m., including types delivering oil-free air. Write now for full details

IMMEDIATE DELIVERY

"BROOMWADE"

Air Compressors and Pneumatic Tools

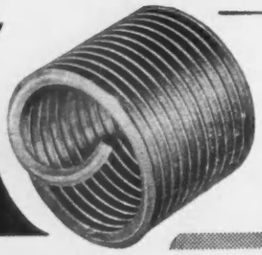
YOUR BEST INVESTMENT

BROOM & WADE LTD., P.O. Box No. 7, HIGH WYCOMBE, ENGLAND

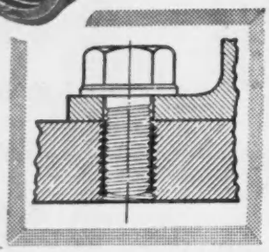
Telephone: High Wycombe 1630 (10 lines) *Telegrams: "Broom", High Wycombe. (Telex)*

607 SAS

Better than New with a . . . .



Cross



BRITISH WIRE THREAD INSERT

PRECISION MADE in CARBON STEEL for ALUMINIUM and MAGNESIUM.

We also make Stainless and Bronze for other applications.

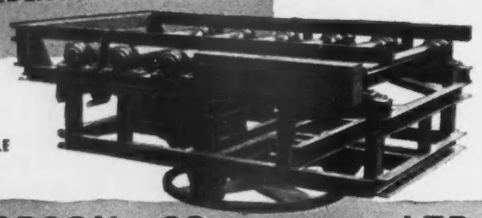
CROSS MANUFACTURING CO. (1938) LTD.

Tel: Combe Down 2355-8 **BATH, SOMERSET** *Grams: Circle, Bath*

Specialists in JET ENGINE LABYRINTHS, CIRCLIPS, SPRING WASHERS, SPRINGS, etc.

ROBSON CONVEYORS

ESTABLISHED 1906



10 TON ROLLER TURNTABLE

Geo. ROBSON & CO. (CONVEYORS) LTD.

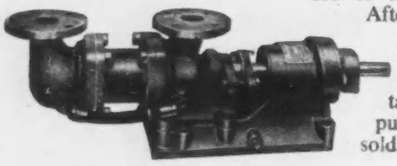
HODGSON STREET · SHEFFIELD.

PHONE. SHEFFIELD, 27463/4

The **MONO pump**

PASSES THE

The "acid" test of the Mono Pump is the great numbers used in Industry. It passes this test with the aid of a team of technicians and by laboratory tests to assess the correct use of the right materials. After making sure the pump fits the job, service does not end there — we always take an interest in the pump after it has been sold.



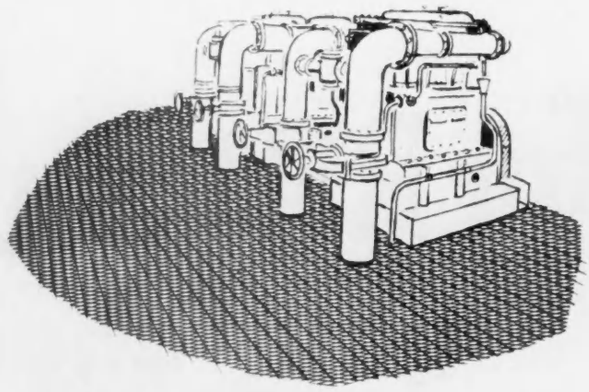
MONO PUMPS LIMITED

Mono House, Sekforde Street, London, E.C.1

Telephone: CLErkenwell 8911 *Telegrams: Monopumps Phone London*

and at Belfast, Birmingham, Capetown, Dublin, Durban, Glasgow, Johannesburg, Manchester, Melbourne, Newcastle, Wakefield

MP 780



Floorway

Walkway

Stairway

Steelway specialise in constructions for Industrial and Civil Engineering contractors.

Our vast experience is at your service.

Fully illustrated catalogue on request.

in steel or aluminium alloy

STEELWAY LIMITED

WOLVERHAMPTON

QUEENSGATE WORKS · WOLVERHAMPTON *Phone: 21633 (2 lines)*

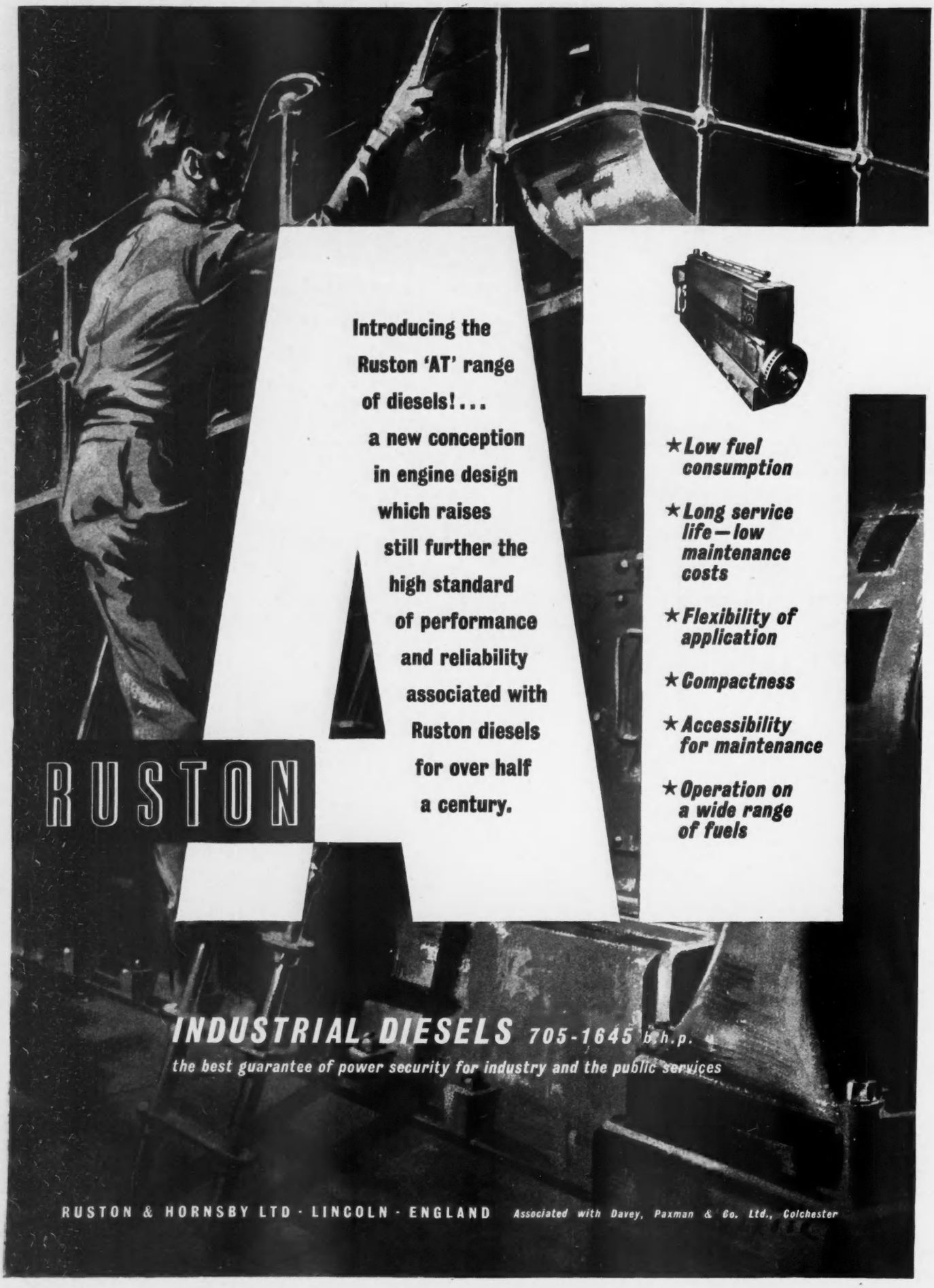
London Office: 25 Hanover Square, London W.1 Phone: Mayfair 8783-8788

WIN THE BATTLE OF THE BURR..

. . BY USING Morrisflex Hammond

BUILT UNDER LICENCE FROM
HAMMOND MACHINERY BUILDERS INC. U.S.A.

B. O. MORRIS LTD. • BRITON ROAD • COVENTRY
Telephone: 53333 (PBX) **Telegrams: MORISFLEX, COVENTRY.**


Introducing the Ruston 'AT' range of diesels!... a new conception in engine design which raises still further the high standard of performance and reliability associated with Ruston diesels for over half a century.
★ Low fuel consumption
★ Long service life—low maintenance costs
★ Flexibility of application
★ Compactness
★ Accessibility for maintenance
★ Operation on a wide range of fuels
RUSTON
INDUSTRIAL DIESELS 705-1645 b.h.p.
the best guarantee of power security for industry and the public services
RUSTON & HORNSBY LTD · LINCOLN · ENGLAND Associated with Davey, Paxman & Co. Ltd., Colchester

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g. ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. " Run-on " and " Semi-displayed " advertisements by noon Tuesday for publication on Friday same week. " Displayed " and " Illustrated " advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

MECHANICAL ENGINEERING DEPARTMENT

SENIOR TECHNICIAN/LABORATORY STEWARD

SENIOR TECHNICIAN/LABORATORY STEWARD required for steam plant laboratory, Mechanical Engineering Department, Imperial College of Science and Technology, London, S.W.7. The laboratory (under construction) will house an oil fired boiler (200/900 p.s.i.g.). Super-critical boiler, water-treatment plant, small turbines and other experimental plants. Successful applicant will be responsible for operating above plants and adjacent air compressor plant with direct charge of his own technician staff. Experience in operating modern high pressure steam plant essential. Salary £615 to £715 per annum, according to experience, plus £45 per annum London Weighting. Superannuation.—Applications in writing to Professor Hugh Ford, by the 17th March, 1959. E5051

UNIVERSITY OF ST. ANDREWS

QUEEN'S COLLEGE, DUNDEE

THE EDWARD A. DEEDS FELLOWSHIP

Applications are invited for the Edward A. Deeds Fellowship in Queen's College, Dundee, within the University of St. Andrews for research in Engineering, Metallurgy, Chemistry, Physics, Mathematical Physics or any cognate subject. The Fellowship (which is open to persons of either sex) is of the value of £1500 per annum, with F.S.S.U. and family allowance benefits. It will be tenable for three years. The Fellow will have the status of a University Lecturer, and may be required, as part of his duties, to do a limited amount of advanced teaching in the Department in which he proposes to work. The appointment will take effect from a date to be arranged, and applicants are requested to submit ten copies of their application to the undernoted not later than 31st March, 1959.

PATRICK CUMMING,
Secretary to the Deeds Fellowship Committee.

February, 1959. E5043

UNIVERSITY OF SHEFFIELD

APPOINTMENTS

Applications are invited for the following posts : duties to commence 1st October, 1959 :

CIVIL ENGINEERING, 1 Lectureship.

ELECTRICAL ENGINEERING, 1 Lectureship (with interests in aspects such as transmission or electrical discharges or servo-mechanisms).

MECHANICAL ENGINEERING, 3 Lectureships.

FUEL TECHNOLOGY and CHEMICAL ENGINEERING, 1 Lectureship, 1 Demonstratorship, 1 Research Assistantship.

Salary scales : Lecturer, £900 by £50 (1), £350 by £75 (1) to £650 ; Demonstrator/Research Assistant, £700, with F.S.S.U. provision and family allowance. Initial salary on the Lecturer's scale according to qualifications and experience. Grants towards removal expenses will be made. Further particulars should be obtained from the Registrar to whom applications (4 copies) should be sent by 4th April, 1959.

Enquirers should name the post in which they are interested. E5047

UNIVERSITY OF BELFAST

LECTURESHIP IN CIVIL ENGINEERING

The Senate of the Queen's University of Belfast invites applications for a Lectureship in Civil Engineering from 1st October, 1959. Salary £900 by £50 to £1300 and by further increments to £1650, plus F.S.S.U. Initial placing on the scale will depend on experience and qualifications. Satisfactory practical experience will be required. Experience in aircraft structures will be an advantage. Applications should be received by 10th April, 1959. —Further particulars may be obtained from G. R. Cowie, M.A., LL.B., J.P., Secretary to the University. E5050

PUBLIC APPOINTMENTS

ROYAL MILITARY COLLEGE OF SCIENCE,
SHRIVENHAM, BERKS

LECTURERS OR SENIOR LECTURERS

Posts for men as LECTURERS or SENIOR LECTURERS (according to age, qualifications and experience), to teach at University level in Mathematics (2 posts) ; Physics (1 post) ; Civil Engineering (2 posts) ; Surveying (1 post—Senior Lecturer) ; Mechanical Engineering (2 posts) ; Radar and Telecommunications or Engineering, Physics or Electrical Engineering (5 posts).

Qualifications : normally 1st or 2nd Class Honours Degree in appropriate subject. (For the Surveying post, professional qualifications in Surveying accepted in lieu.) Teaching experience and research ability desirable for most posts. Some posts require special qualifications or experience in, e.g., solid state Physics, atomic or nuclear Physics, Physics of irradiated materials, Materials and Structures, Fluid Mechanics, Mechanics of Machines, Machine Tools, Production Engineering, Electrical Theory and Measurements, Electrical data transmission, Computing and Automatic Control Devices and Systems, Electric Power and Machines, Electronic Engineering and Instrumentation, Radar and Guided Weapons, Telecommunications, General Instrumentation, including optical and infra-red techniques, servo-mechanisms, theory and practice analogue and digital computing methods.

Salary scales : Lecturer, £615–£1120, or Senior Lecturer, £1166–£1420. Starting pay may be above minimum in both cases. Appointment on the higher scale will not normally be made below age 26. Secondment from, and transfer to, the Scientific Civil Service possible. Prospects of pensionable employment and of promotion. Existing superannuation rights preserved where possible. House available, after a waiting period for married men, and quarters for single men. Candidates should be available to take up duty on or about September 1st, 1959.

Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S4947/59/12. Closing date 31st March, 1959. E5039

BRADFORD INSTITUTE OF TECHNOLOGY

Principal : E. G. EDWARDS, Ph.D., B.Sc., F.R.I.C.

DEPARTMENT OF MECHANICAL ENGINEERING

SENIOR LECTURER

Applications are invited for appointment of SENIOR LECTURER in the Department of Mechanical Engineering. Applicants should be Graduates, and Corporate Membership of a professional institution is desirable.

The salary scale for men, in accordance with the Burnham Technical Award, is from £1417 10s. to £1627 10s. per annum.

Previous industrial or research experience at a suitable level may be taken into account in fixing the commencing salary.

Further particulars and forms of application may be obtained from the Registrar, Institute of Technology, Bradford, 7.

W. H. LEATHEM,
Clerk to the Governors.

E5034

UNIVERSITY COLLEGE OF SWANSEA

ASSISTANT LECTURESHIPS OR LECTURESHIPS

Applications are invited from suitably qualified candidates for ASSISTANT LECTURESHIPS or LECTURESHIPS in the following subjects :

Civil Engineering
Mechanical Engineering
Chemical Engineering.

Salary scales :

Assistant Lectureships : £700 by £50 to £850 per annum.

Lectureships : £900 by £50 to £1350 by £75 to £1650 per annum.

F.S.S.U. benefits and family allowances.

Further particulars can be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received not later than Saturday, April 4, 1959. E5075

PUBLIC APPOINTMENTS

COLLEGE OF TECHNOLOGY, COVENTRY

Principal : A. J. RICHMOND, B.Sc. (Eng. Lond.), Ph.D., M.I.Mech.E.

APPOINTMENTS

This College is to open in new premises close to the City centre by September, 1960, and will offer advanced courses in Science, Technology and Commerce in nine Departments. The present Coventry Technical College will then exist as a separate institution, offering G.C.E., Craft and O.N.C. courses. The Governors now seek to fill the following key posts from May, 1959, or as soon as possible thereafter.

(1) HEAD OF MECHANICAL ENGINEERING DEPARTMENT, Grade IV. Salary (men), £1837 10s. by £52 10s. to £1995.

(2) HEAD OF PRODUCTION ENGINEERING DEPARTMENT, Grade III. Salary (men), £1680 by £52 10s. to £1837 10s.

(3) REGISTRAR, HEAD OF DEPARTMENT, Grade I. Salary (men), £1312 10s. by £31 10s. to £1470.

An exceptional opportunity exists for person with high qualifications and vision to make a contribution in planning and establishing a new College.

Application forms and further particulars (including qualifications required) may be obtained from the Principal, Technical College, Butts, Coventry. Closing date for applications, 26th March, 1959.

W. L. CHINN,
Director of Education

E5102

CITY OF LIVERPOOL EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY
BYROM STREET, LIVERPOOL, 3

DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING

SENIOR LECTURER

The Governing Body invite applications for the appointment of SENIOR LECTURER (full-time). Duties to commence as soon as possible. Salary : (Men) : £1350 by £50 to £1550 p.a., plus 5 per cent (Burnham Technical Report). Applicants should be graduates in Mechanical Engineering, with industrial and preferably research experience. Teaching experience to Higher National Certificate and Diploma standard, particularly in Theory of Machines and Thermodynamics or Mechanics of Fluids is desirable.

Further particulars and application form (returnable by 31st March, 1959) from H. S. Magnay, M.A., Director of Education, 14, Sir Thomas Street, Liverpool, 1.

THOMAS ALKER,
Town Clerk and Clerk to the Local Education Authority.

(J.5550) E5067

ROYAL MILITARY COLLEGE OF SCIENCE,
SHRIVENHAM, BERKS

ASSOCIATE PROFESSORS

Four new pensionable posts in residential College for men of high standing in their subjects in the following branches : Ballistics (Department of Mathematics and Physics) ; Applied Chemistry (Department of Chemistry and Metallurgy) ; Mechanics (Department of Civil and Mechanical Engineering) ; Radar and Telecommunications (Department of Electrical and Instrument Technology). The successful candidates will be heads of their respective branches and should preferably be experienced teachers. They will be expected to undertake and lead research in their own fields and to teach to Degree and post-graduate level. Good facilities for instruction and research are available. Salary : £2100 (or over) to £2350. Existing superannuation rights preserved where possible. Secondment from, or transfer to, Scientific Civil Service possible. Rented house available (after a waiting period) for married men, and quarters for single men.

Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S4949/59/12. Closing date 31st March, 1959. E5040

PUBLIC APPOINTMENTS

THE POLYTECHNIC,
309, REGENT STREET, W.1

CIVIL AND MECHANICAL ENGINEERING DEPARTMENT

APPOINTMENTS

Applications are invited for the following posts, duties to commence on 1st September, 1959.

(1) LECTURER, to be responsible for the Mechanical Engineering Workshop and the development of courses with a Production bias. The successful candidate will be expected to lecture on Machine Tools, Metrology, or Jig and Tool Design.

The salary scale commences at £1260 and rises to £1417 10s. per annum, plus London allowance of £37 16s. or £50 8s. per annum.

(2) Grade B ASSISTANT, to teach Workshop Practice and Workshop Technology and Drawing.

The salary scale rises to a maximum of £1076 5s. per annum, plus London allowance of £37 16s. or £50 8s. per annum. Additional allowances are payable in respect of Graduate status and training, where applicable.

The commencing salary in each case will depend upon qualifications and previous experience in industry or teaching. The posts are subject to superannuation and some concession in this respect may be made for previous industrial employment.

Further particulars and a form of application, which should be returned by not later than 3rd April, 1959, may be obtained from the undersigned.

J. E. RICHARDSON,
Director of Education.

E5111

NORWICH CITY COLLEGE AND ART SCHOOL,
IPSWICH ROAD, NORWICH

Principal : FRANK BRIERS, B.Sc., D.Phil.(Oxon.), F.R.I.C.

ASSISTANT LECTURER

WANTED as soon as possible :

ASSISTANT LECTURER, Grade B, in Mechanical Engineering. Duties will involve teaching Engineering Science, Engineering Drawing and Applied Mechanics in the National Certificate and City and Guilds courses. Opportunity will be given to teach special subject(s) at advanced levels.

Salary Burnham Technical Scale, Grade B (£682 10s. by £25 to £1076 5s., plus allowances for approved industrial and teaching experience).

Application forms, which may be obtained from the Director of Education, City Hall, Norwich, on receipt of a stamped addressed envelope, should be returned to the Principal as soon as possible. E5063

UNIVERSITY OF LIVERPOOL

DEPARTMENT OF CIVIL ENGINEERING

LECTURER

Applications are invited for the post of LECTURER in the Department of Civil Engineering. The initial salary will be within the range £900–£1250 per annum, according to age, qualifications and experience.—Applications, stating age, academic qualifications and experience, together with the names of three referees, should be sent as soon as possible to the Registrar, from whom further particulars of the conditions of appointment may be obtained. E9982

UNIVERSITY OF CAMBRIDGE

A.E.I. FELLOWSHIPS

Applications are invited for the Associated Electrical Industries Fellowship tenable in the Department of Engineering from 1 October, 1959. Stipend within the range £900–£1400 a year with family allowances and F.S.S.U. benefits. Available for research in any branch of Engineering.—Particulars may be obtained from the Secretary General of the Faculties, The Old Schools, Cambridge, to whom all applications should be sent not later than 31 May, 1959. E5014

Classified Advts. continued on page 128

PUBLIC APPOINTMENTS

UNIVERSITY OF BRISTOL

LECTURERS

Applications are invited for two posts as LECTURER (one Grade II and one Grade III) in the Department of Mechanical Engineering, at an initial salary within the range :

Grade III : £700 to £850 per annum
Grade II : £900 to £1650 per annum

according to qualifications and experience, with F.S.S.U. benefits and Family Allowance. Applicants should have good academic qualifications and practical experience.

Further particulars may be obtained from the undersigned to whom applications (including the names of two persons to whom reference may be made) should be sent not later than 16th March, 1959.

H. C. BUTTERFIELD,
Registrar and Secretary.

E9992

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

INDUSTRIAL GROUP HEADQUARTERS

ENGINEER

ENGINEER required by the United Kingdom Atomic Energy Authority, Industrial Group Headquarters, in the Mechanical Engineering Services Design Office at Risley, Warrington, Lancashire, to lead a team engaged on the design, specification, supply and installation of cranes, lifts, machine tools and special mechanical plant. Close collaboration with other design offices and branches of the Authority is maintained.

A recognised engineering apprenticeship, corporate membership of the Institution of Civil or Mechanical Engineers, or equivalent and wide experience in mechanical engineering are essential and particular attention will be paid to knowledge of the statutory regulations relating to cranes, lifts and machine shops.

Salary between £1345 and £1800 according to qualifications and experience.

Contributory Superannuation. Staff housing scheme.

Send postcard for application form quoting reference 2964/31, to Recruitment Officer, at above address.

Closing Date : 16th March, 1959. E5048

CENTRAL ELECTRICITY GENERATING BOARD

YORKSHIRE DIVISION

FOURTH ASSISTANT ENGINEER

Applications are invited for the position of FOURTH ASSISTANT ENGINEER in the Efficiency and Testing Section of the Generation Operation Department based at Skelton Grange Power Station, Leeds.

Commencing salary within the range £735–£860 per annum, Grade 8, Class AX, National Joint Board Agreement Schedule "B" according to qualifications and experience, rising to a maximum of £960 per annum (Class EX).

Applicants should be educated to at least Higher National Certificate standard in Mechanical Engineering, and should preferably have had experience of operation in modern power stations.

Duties will include the testing of power station plan throughout the Division, and the preparation of reports. The successful applicant will be expected to travel in connection with his duties.

Application forms obtainable from the Divisional Secretary (Establishments), Central Electricity House, St. Mary's Road, Leeds, 7, to be returned within 14 days of the appearance of this advertisement.

E5072

ADMIRALTY

LONDON, BATH, AND H.M. DOCKYARDS

ELECTRICAL ENGINEERS AND ASSISTANT ELECTRICAL ENGINEERS

Admiralty requires ELECTRICAL ENGINEERS and ASSISTANT ELECTRICAL ENGINEERS for unestablished appointments in London, Bath and H.M. Dockyards. Candidates must be British subjects, possess University Honours Degree or equivalent qualifications, with at least two years' practical training followed by practical experience in responsible post. Salaries depending on age and experience within ranges : Electrical Engineer, £1445 to £1975 ; Assistant Electrical Engineer, £865 (age 25) to £1345 (London rates, subject to reduction in provinces).—Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D63/9A. E9874

ST. HELIER GROUP HOSPITAL MANAGEMENT COMMITTEE

ST. HELIER HOSPITAL, CARSHALTON, SURREY

SENIOR ENGINEER

SENIOR ENGINEER required to work under direction of Superintendent Engineer. Experience in supervision of plant maintenance of oil and coal-fired boilers, heating and mechanical ventilating systems, H.W.S. and kitchen equipment necessary. Applicants must be capable of making drawings of plant layouts, &c.

Salary £700 by £25 (3) by £30 (2) to £835, plus London weighting. Superannuation scheme.

Details of age, qualifications and experience, with the names of 2 referees, to be sent to Group Secretary by 12th March, 1959. E5057

PUBLIC APPOINTMENTS

COUNTY BOROUGH OF SWANSEA

WATER DEPARTMENT

APPOINTMENTS

Applications are invited for the following appointments to the permanent staff :—

(a) SUPPLY WORKS ENGINEER.
(b) ASSISTANT ENGINEER (PLANNING).
(c) JUNIOR ENGINEERING ASSISTANT.

The salary for posts (a) and (b) will be in accordance with Grade A.P.T. IV (£1025–£1175), and the salary for post (c) will be in accordance with Grade A.P.T. I (£575–£725) of the National Joint Council for Local Authorities Administrative, Professional and Technical and Clerical Services.

Applicants for post (a) must be Corporate Members of the Institution of Civil Engineers and have had experience of the maintenance and operation of impounding reservoirs, filtration plants and large mains.

Applicants for post (b) must be Corporate Members of the Institutions of Civil or Structural Engineers, and have considerable experience of the design of reinforced concrete structures, preferably of a type for the retention of liquids. Experience in the design of pipelines and hydraulic calculation will be an advantage.

Applicants for post (c) should have experience in drawing-office work and be competent draughtsmen. Preference will be given to those possessing technical qualifications or who are studying with a view to qualifying as civil engineers.

All appointments are subject to the National Scheme of Conditions of Service, the Local Government Superannuation Act and a satisfactory medical report.

The Corporation will endeavour to assist successful applicants for posts (a) and (b) with housing accommodation if married.

Applications, stating age, qualifications, all former Local Government service, present and previous appointments and experience, and the names of two referees must be forwarded to the Borough Water Engineer and Manager not later than the 19th March, 1959.

Canvassing will disqualify.

T. B. BOWEN,
Town Clerk.

The Guildhall,
Swansea,
19th February, 1959. E5052

TYNE IMPROVEMENT COMMISSION

ENGINEERING APPOINTMENTS

The Tyne Improvement Commission, the Dock and Harbour Authority for the Port of Tyne, invites applications for the following appointments :

ASSISTANT ENGINEER

Applicants must be Chartered Civil Engineers with extensive experience in the design, execution and maintenance of civil engineering works. The position offers interesting work on general dock and harbour engineering.

Starting salary will be not less than £1175 per annum.

CIVIL ENGINEERING ASSISTANTS

Applicants should be advanced towards professional qualifications in civil engineering. Some practical training, together with some drawing-office experience, is essential.

Starting salary will be not less than £630 per annum.

ENGINEERING SURVEYING ASSISTANT

Applicants should have had good general experience in making and plotting detailed surveys and be competent draughtsmen.

Starting salary will be not less than £590 per annum.

Salaries will have regard to the qualifications and experience of successful applicants.

The appointments will be superannuable and subject to the passing of a medical examination.

Applications, stating age, education, training, qualifications and experience, and giving the names and addresses of two referees as to training and experience, should reach the undersigned not later than Tuesday, 31st March, 1959.

R. N. EGGLETON,
Secretary.

Bewick Street,
Newcastle upon Tyne, 1. E5069

SOUTH CHESHIRE HOSPITAL MANAGEMENT COMMITTEE

(GROUP COMPRISING 8 HOSPITALS AND 3 CLINICS)

SUPERINTENDENT ENGINEER

Applications are invited for the appointment of SUPERINTENDENT ENGINEER, which will become vacant on 1st April, 1959. This group appointment covers the full range of mechanical and electrical engineering duties and responsibilities for the maintenance of services at the above Hospitals and Clinics.

Candidates must have passed an examination in engineering technology and hold one of the following qualifications :—

First Class Certificate of Competency in Marine Engineering or equivalent Naval Certificate.

City and Guilds Full Technological Certificate in Plant Engineering.

Higher National Certificate in Mechanical Engineering.

Experience in a large hospital or hospital group is desirable.

The salary and conditions of service are in accordance with the Professional and Technical "B" Whitley Council based on a pointage range of (20)–30 points) £890 by £25 (2) by £30 (1) by £35 (1) by £40 (1) to £1045. The post is terminable by one month's notice by either side.

Applications must be accompanied by full details of experience and qualifications, together with the names and addresses of three referees, and sent to the Group Secretary, Barony Hospital, Nantwich, Cheshire, within 10 days of the appearance of this advertisement. E5085

PUBLIC APPOINTMENTS

COUNTY BOROUGH OF SWANSEA

WATER DEPARTMENT

PRIMARY DISTRIBUTION SYSTEM—EASTERN AREA

REINFORCED CONCRETE RESERVOIR, MAINS AND ANCILLARY WORKS

RESIDENT ENGINEER

The Corporation is about to undertake a scheme for the improvement of water supplies in the Borough involving the design and construction of a pumping station, 3 million gallon capacity reservoir, and 5 miles of mains, 24in. to 9in. diameter.

Applications are invited for the appointment of a RESIDENT ENGINEER to assist with the design and supervise the carrying out of the above works. The salary will be £1200 per annum and it is anticipated that the works will be completed within 2½ years.

Applicants must be Corporate Members of the Institution of Civil Engineers and have had specialised experience of the design and execution of reinforced concrete works, and be competent to supervise the construction of such works and the laying and testing of large mains.

The appointment will be subject to the National Scheme of Conditions of Service, the Local Government Superannuation Act, and a satisfactory medical report. The appointment will be temporary and terminable by one month's notice on either side.

Applications, stating age, qualifications, any former Local Government service, present and previous appointments, and the names of two referees must be forwarded to the Borough Water Engineer and Manager, The Guildhall, Swansea, not later than the 19th March, 1959.

Canvassing will disqualify.

T. B. BOWEN,
Town Clerk.

The Guildhall,
Swansea,
19th February, 1959. E5053

ROCHDALE AND DISTRICT HOSPITAL MANAGEMENT COMMITTEE

APPOINTMENT OF SUPERINTENDENT ENGINEER

Applications are invited from suitably qualified persons for the above position. Applicants must have served a full apprenticeship or have otherwise acquired a thorough practical training in mechanical engineering. New entrants to the Health Service must have passed an examination in Engineering Technology and must possess one of the following qualifications :

Ministry of Transport and Civil Aviation : First Class Certificate of competency in Marine Engineering. Certificate of Service as First Class Engineer.

City and Guilds full Technological Certificate in Plant Engineering (First Class).

Duties involve the maintenance and co-ordination of all mechanical and electrical engineering services in this Group of seven hospitals. Applicants must have a sound knowledge of the principle and practice of the efficient operation of steam boiler plants, and a wide experience in a supervisory position of mechanical and electrical engineering services found in hospitals.

Salary in accordance with the Whitley Scale for 40½–50 points range, viz. £1020 rising by five annual increments to £1180.

Forms of application may be obtained from the Group Secretary, Central Offices, Birch Hill Hospital, Rochdale, Lancs. Closing date for receipt of completed application forms—27th March, 1959.

E5042

ESSEX RIVER BOARD

ENGINEERING ASSISTANT, A.P.T. IV (£1025–£1175)

Applications are invited for two permanent posts on the above scale at the Board's Head Office at Chelmsford.

Applicants should be Chartered Civil Engineers experienced in the design and calculation of river improvement schemes or surface water sewerage schemes. Experience in the design of pumping stations or coast protection works would be an advantage.

Applications, giving details of age, education and previous experience, and the names of three referees with a knowledge of the applicant's technical experience, should be submitted to the Engineer to the Board at the address given below, not later than Saturday, 14th March, 1959.

(Signed) W. J. S. BEW,
Clerk of the Board.

Rivers House,
129, Springfield Road,
Chelmsford, Essex,
6th March, 1959. E5096

COUNTY BOROUGH OF PRESTON

PORT OF PRESTON AUTHORITY

ASSISTANT ENGINEER (CIVIL)

Applications are invited for the post of ASSISTANT ENGINEER (CIVIL) in the Chief Engineer's Department of the Port of Preston Authority.

Candidates should be Corporate Members of the Institution of Civil Engineers or hold equivalent qualifications, and have good experience in design, specifications, construction and maintenance of civil engineering works. Dock and harbour experience is preferable, but not essential.

Salary, Grade A.P.T. IV (£1025 by £25 to £1175).

The appointment will be subject to the Local Government Superannuation Acts, to the National Scheme of Conditions of Service, and to one month's notice on either side.

Application forms may be obtained from the undersigned, to whom they should be returned not later than 31st March, 1959.

W. E. E. LOCKLEY,
Town Clerk.

Municipal Building,
Preston, Lancs. E5056

PUBLIC APPOINTMENTS

RUGBY RURAL DISTRICT COUNCIL

WIBTOFT WATER SUPPLY—CONTRACT NO. 12

WOLSTON AREA SEWERAGE AND SEWAGE PURIFICATION—CONTRACT NO. 13

APPOINTMENT OF RESIDENT ENGINEER

Applications are invited for the above appointment, to supervise the following works :

CONTRACT No. 12

The construction of one 220,000 gallon reinforced concrete reservoir, including valve house, about 8 miles of asbestos cement and spun-iron water mains, 3 inch to 8 inch, and the provision of service connections.

CONTRACT No. 13

The laying of 5½ miles of concrete and salt-glazed ware sewers, 3¼ miles of asbestos cement pumping mains, three pumping stations and the construction of sewage purification works for 7000 people.

It is expected that Contract No. 12 will commence a few months before Contract No. 13 and both will be under the direction of the Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, London, S.W.1.

The salary is £1200 per annum and the appointment, subject to satisfactory service, will last approximately 2 years and will be terminable by 2 months' notice on either side.

The period of employment may be extended to cover the supervision of further works of a similar nature within the Rural District, which it is expected will form the subject of subsequent Contracts.

A car mileage allowance will be paid.

Applicants, who should be Associate Members of the Institution of Civil Engineers or have comparable qualifications and must have had experience of similar work, should apply in writing to the undersigned not later than 23rd March, 1959, giving full particulars of age, qualifications and experience, and the names and addresses of two persons to whom reference may be made.

Canvassing will disqualify.

H. A. WILDE,
Clerk of the Council.

Council Offices,
24, Warwick Street,
Rugby.
20th February, 1959. E5026

LIVERPOOL REGIONAL HOSPITAL BOARD

APPOINTMENTS

Applications invited from suitably qualified persons for the following permanent pensionable appointments on the staff of the Regional Engineer :—

(a) SENIOR ASSISTANT ENGINEER (MECHANICAL)
Salary scale : £1010 by £30 (5) by £35 (1) to £1195.
Applicants should hold Corporate Membership of I.Mech.E. and be fully experienced in the preparation of drawings and specifications and the conducting of site surveys in connection with kitchens, laundries and heating and ventilating schemes.

(b) ASSISTANT ENGINEER (MECHANICAL)
Salary scale : £700 by £25 (3) by £30 (1) by £35 (6) to £1015.
Applicants should be at least G.I.Mech.E., or A.M.I.H. and V.E., and have passed the appropriate Institution examinations, be experienced in the preparation of drawings and specifications and the conducting of site surveys in connection with engineering equipment and heating and ventilating schemes.

(c) DRAUGHTSMAN (MECHANICAL)
Salary scale : £425 (at age 21 and over) by £25 (6) by £30 (2) to £635.
Applicants should have had at least three years' technical experience in a mechanical engineering drawing-office and have had some site or workshop experience.

(d) JUNIOR DRAWING-OFFICE ASSISTANT (MECHANICAL)
Salary scale : £205 (male) ; £201 (female), at age 16, rising to £440 at age 25 years.
Applicants should have had a good standard of education, and it is desirable that the successful candidate should acquire technical qualifications whilst holding the post.

(e) TRACER (MECHANICAL)
Salary scale : £425 by £25 to £470
Applicants should have had a good standard of education and at least three years' previous experience as a tracer in a mechanical engineering drawing office.

(f) CLERK OF WORKS (ELECTRICAL)
Salary scale : £635 by £20 (2) by £25 (3) to £750.
Applicants should have served a recognised apprenticeship as a craftsman and have had at least three years' experience as a foreman. Should have experience in supervising and inspecting electrical installations on building contracts and have a good knowledge of the I.E.E. Regulations.

All salary scales at present under review.

Applications, stating age, qualifications, experience, present and previous posts and clearly stating the post applied for, with names and addresses of three referees (2 technical), to reach me at 55, Castle Street, Liverpool, 2, by 27th March, 1959.

VINCENT COLLINGE,
Secretary to the Board.

E5013

MINISTRY OF POWER

INSPECTORS OF MECHANICAL ENGINEERING IN MINES AND QUARRIES

Two pensionable posts for men at least 27 on 1st March, 1959, who have achieved Corporate Membership of Institution of Mechanical Engineers or have passed examinations recognised for the attainment of such membership and have held senior responsible post to do with mechanical engineering plant at coal mines for at least two years since 1953. National salary scale : £1950 to £2150. Promotion prospects. —Write, Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S4946/59. Closing date 1st April, 1959. E5055

BOOKS and PUBLICATIONS

JUST PUBLISHED –

"A complete library in two volumes.."

KEMPE'S

Engineers Year-Book

Edited under the direction of the Editor of "The Engineer"

1959 (64th Edition)

82/6 (plus postage 2/6)

★ **3,000 pages covering modern theory and practice in all branches of engineering. No other single publication devoted to engineering covers a comparable range of subjects so concisely.**

ORDER YOUR COPY NOW

Obtainable direct from the publishers or through your local booksellers

Kempe's Engineers Year Book

28 Essex Street, Strand, London, W.C.2

Telephone: Central 6565

Electronic Engineering

A monthly journal for the professional electronics engineer.

It circulates to 86 different industries all over the world.

When electronic engineering is studied "Electronic Engineering" is read.

Published on last Friday of preceding month.

Price 3/- per copy. 36/- per Annum.

28 ESSEX STREET, STRAND, W.C.2

Telephone: Central 6565

Published by Morgan Bros. (Publishers) Ltd.

PUBLIC APPOINTMENTS

UNITED LIVERPOOL HOSPITALS

SUPERINTENDENT ENGINEER

Applications are invited for the new post of SUPERINTENDENT ENGINEER. The person appointed will be the senior professional engineer in a group of ten hospitals with a total of 1800 beds. He will be responsible for the efficient operation of the engineering plant and services, including electromedical and other specialised apparatus, and will be in charge of the building and engineering maintenance staff. He may from time to time be required, to design and supervise the installation of engineering plant. The possession of a higher professional qualification is desirable, but candidates will be considered who hold a Ministry of Transport and Civil Aviation Extra First Class Certificate of Competency in Marine Engineering or a Higher National Certificate or Diploma (or its equivalent) in Mechanical or Electrical Engineering. Practical experience in hospital engineering, and in the design and construction of new works, is desirable. The salary scale is £1400 a year, rising in five yearly increments to £1600 a year. Consideration will be given to a higher minimum salary for a candidate with previous experience at the same level of responsibility. Whitley Council Conditions of Service will apply.—Apply, stating age, qualifications and experience, and the names and addresses of three persons to whom reference may be made, to the Secretary, The United Liverpool Hospitals, 80, Rodney Street, Liverpool, 1, by 10th April, 1959. E5091

PUBLIC APPOINTMENTS

BRITISH WATERWAYS

ENGINEER (MECHANICAL AND ELECTRICAL)

British Waterways invite applications for the post of ENGINEER (MECHANICAL AND ELECTRICAL) in their South Eastern Divisional Office at Watford. Applicants must be either Corporate Members of the Institution of Mechanical Engineers, with good electrical experience, or Corporate Members of the Institution of Electrical Engineers, with good mechanical experience.

The salary range for the post is from £1315 to £1590 per annum, and in addition certain privilege railway travel facilities are available. The successful applicant will be required to contribute to a superannuation scheme which is in operation. The person appointed will be responsible under the Divisional Engineer for the control of junior engineers responsible for the maintenance of plant, equipment and craft and for the control of the preparation of drawings and specifications for all new plant and craft which will be required. Wide practical experience in the control and operation of workshops and sound administrative ability with good powers of control of junior staff are essential.

Further information can be obtained from and application should be made to : Staff and Establishment Officer, British Waterways, 163, Euston Road, London, N.W.1, by 20th March, 1959. E5110

CENTRAL ELECTRICITY GENERATING BOARD

PLANNING DEPARTMENT

SENIOR ASSISTANT ENGINEERS

are required in the STATION PLANNING SECTION at Headquarters, London, S.E.1.

The Section is concerned with the planning of new generating capacity throughout England and Wales, the investigation and selection of sites for conventional and nuclear power stations, and negotiations for statutory and other consents for both classes of station.

Candidates should have a sound engineering or scientific background and must possess an Honours Degree or the requisite qualifications for Corporate Membership of a senior Engineering Institution.

An aptitude for forward thinking, experience of economic studies, or experience of one or more of the problems arising in the siting of power stations, e.g. geology and ground exploration, thermal and hydraulic aspects of the use of large volumes of river or sea water for cooling purposes, questions of town and country planning, would be an advantage.

Salaries within scales £1590–£1940 or £1475–£1835 p.a., according to duties and responsibilities.

Application form obtainable from the Personnel Officer, 24/30, Holborn, London, E.C.1, should be completed and returned by 23rd March. Please mark envelopes "Confidential Ref. ENR/69.

E5074

BOOKS and PUBLICATIONS

PUBLISHED AS OF MARCH 9, 1959, a work entitled "BEARING MANUAL No. 59," by Bearing Manual Inc., of 9, South Clinton Street, Chicago, State of Illinois, United States of America. —All enquiries relating to this matter should be addressed to Marks & Clerk, 57/58, Lincoln's Inn Fields, London, W.C.2. E5108 P

TENDERS

TAMAR BRIDGE JOINT COMMITTEE

CORNWALL COUNTY COUNCIL AND PLYMOUTH CITY COUNCIL

TAMAR BRIDGE

TENDERS are invited from contractors of considerable experience on very large engineering contracts for :

(a) The Construction of Piers in the River Tamar for towers for a new suspension bridge.

(b) The Construction of Side Piers clear of the river on each side.

(c) The Construction of Tunnel Anchorages in rock on each side of the river.

(d) The Construction of Reinforced Concrete Towers for the suspension bridge on the abovementioned piers.

(e) The provision and Erection of High Tensile Steel Cables for suspension bridge of 1100ft. central span and 374ft. side spans.

(f) The Provision and Erection of Steelwork in stiffening truss for suspension bridge of abovementioned span.

(g) Reinforced Concrete Deck to Main Bridge, reinforced concrete side spans, earthworks, and roadworks on each side of the river.

All steel to be used in the work must be to British Standard Specification.

Experienced contractors wishing to tender for the above works should apply for permission to tender to the Consulting Engineers, Messrs. Mott, Hay and Anderson, 9, Iddesleigh House, Caxton Street, Westminster, London, S.W.1. from whom copies of the drawings and Contract Documents will be obtainable. The selected contractors will be required to make a deposit of £30 made payable to the Tamar Bridge Joint Committee. Tenders are to be returned so as to reach the Joint Clerks to the Tamar Bridge Joint Committee at Pounds House, Peverell, Plymouth, not later than 12 noon on Tuesday, 26th May, 1959.

E. T. VERGER,
S. LLOYD JONES,
Joint Clerks.

E5044

TENDERS

DUNMOW RURAL DISTRICT COUNCIL

GREAT EASTON AND DUTON HILL

SEWERAGE EXTENSIONS

CONTRACT NO. 15

TENDERS are invited on a fixed price basis in accordance with the Ministry of Housing and Local Government Circular No. 31/57, for the CONSTRUCTION of SEWERAGE EXTENSIONS at Great Easton and Duton Hill.

The sewerage comprises in all the laying of about 5000 linear yards of 6 inch diameter S.G.W. sewer, together with 4 inch and 6 inch diameter S.G.W. house connections and construction of 11 brick and 37 precast concrete manholes.

General conditions of contract, specification, bill of quantities and drawings may be obtained from the Council's Consulting Engineers, Messrs. J. D. and D. M. Watson, MM.I.C.E., 67, Tufton Street, Westminster, S.W.1, on and after 9th March, 1959, on payment of a deposit of ten guineas refundable only to Contractors who submit bona fide Tenders and return all documents and drawings. Deposit cheques should be made payable to Dunmow Rural District Council.

The Council do not bind themselves to accept the lowest or any Tender.

Tenders must be returned in envelopes which do not bear any name or mark indicating the sender, endorsed "Tender for Sewerage Contract 15," and delivered at the office of the undersigned by noon on 17th April, 1959.

A. H. BURTON,
Clerk of the Council.

Council Offices,
Dunmow,
Essex.

E5103

THANET WATER BOARD

DANE PUMPING STATION

SUBMERSIBLE WELL PUMP UNIT

TENDERS invited for PROVISION and ERECTION of ONE SUBMERSIBLE WELL PUMP UNIT to deliver 13,000/20,000 g.p.h. against 160/210ft. head. Applications for documents to Engineer, 58, Victoria Road, Margate, to whom the Tenders are to be submitted not later than 27th March, 1959.

The Board does not bind itself to accept the lowest or any Tender.

March, 1959. E5107

Classified Advts. continued on page 130

TENDERS

INDIA SUPPLY MISSION

SUPPLY OF HEAVY-DUTY GATHERING ARM TYPE CRAWLER MOUNTED LOADER

The office of the India Supply Mission, 2536 Massachusetts Avenue, N.W., Washington, D.C., United States of America, invites TENDERS for the following :—

" TENDER ENQUIRY No. S.E.28 "

For the SUPPLY of HEAVY-DUTY GATHERING ARM TYPE CRAWLER MOUNTED LOADER for use in Indian Coal Mines. Capacity 4 tons/min., gradient 1 in 4, loading height 2 to 5 feet.

Specifications, &c., regarding the above enquiry can be obtained direct from the Co-ordination Department, India Store Department, Government Buildings, Bromyard Avenue, Acton, W.3, at 14s. 3d. per set. Tenders are to be returned direct to India Supply Mission, 2536, Massachusetts Avenue, N.W. Washington, D.C., United States of America, so as to reach them by Monday, the 20th April, 1959.

Specimen copy of the above specification can be seen at India Store Department, Government Buildings, Bromyard Avenue, Acton, W.3, under reference S.4290/58/AVH/ENG.2. E5093

INDIA STORE DEPARTMENT

ONE CARTRIDGE CASE AUTOMATIC LATHE

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the supply of :

ONE CARTRIDGE CASE AUTOMATIC LATHE for head turning and threading of primer hole in brass cases 7in. diameter by 36in. long.

Tender schedules and specifications may be obtained from the above address at a fee of ten shillings which is not refundable. Cheques should be made payable to High Commission of India. The applications for tender forms should state reference 2030/58/ENG.3.

Tenders complete with specifications are to be submitted by THURSDAY, 16th April, 1959. E5068

EDUCATIONAL

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

BURSARIES AVAILABLE FOR POST-GRADUATE COURSES in Chemical, Civil, Electrical and Mechanical Engineering for Session 1959–60. Value £500–£700 per annum. Applicants, who should be United Kingdom residents, must have spent at least one year away from University since graduation, preferably in industry.—Further information and application forms from Registrar, Imperial College, London, S.W.7. Closing date May 18th, 1959. E9980 E

INSTITUTION OF ELECTRICAL ENGINEERS

SCHOLARSHIPS

The Council of The Institution of Electrical Engineers will consider for award this year THREE RESEARCH SCHOLARSHIPS, TWO GRADUATE SCHOLARSHIPS and SEVEN STUDENT SCHOLARSHIPS for study at universities and technical colleges. Research Scholarships : value £100–£500 per annum. Graduate Scholarships : value £400 per annum. Student Scholarships : value £50–£200.

The closing date for the receipt of applications is the 1st May, 1959, for Student Scholarships, and the 1st June, 1959, for Graduate and Research Scholarships.

Full particulars of the conditions of award and nomination forms may be obtained on application to the Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C.2. E5045 E

TECHNICAL HOME STUDY COURSES

For A.M.I.Mech.E., A.M.I.Chem.E., A.M.I.M.I., A.F.R.Ae.S., C. & G., &c.

OVER 50 FIRST PLACES and more than 2000 Passes have been secured by T.I.G.B. Students at Professional Engineering Examinations. We have a wide range of exclusive Home Study Courses in all branches of Engineering—Mechanical, Electrical, Aeronautical, Automobile, Chemical, Gas, Radio, and Television, Draughtsmanship, &c. Textbooks, blueprints, &c., are provided and, if desired, fees may be paid by moderate instalments.—Write (stating subject of interest) for copy of 110-page Prospectus FREE and without obligation.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
(Dept. 76),
29, WRIGHTS LANE, LONDON, W.8.
E102 E

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

AUTOMATION.—AUTHORITATIVE COURSES are now available in Digital and Analogue Computer Technology, Applied Electronics, Data Processing and Instrumentatio up to professional level by home study. Individual enrolment or industrial group scheme enrolments accepted. Syllabuses and prospectus sent on request.—Write (Dept. S.E.8), E.M.I. Institute School of Electronics, College House, Kensington, London, W.8. E145 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A TECHNICAL SERVICE ENGINEER is required by Dresser (Great Britain), Ltd., Clark Bros. Co. Division. This Division is responsible to the United States Parent Company for the marketing of gas engines, motor-driven reciprocating compressors, centrifugal compressors and gas turbines, manufactured under licence in the United Kingdom and on the Continent. Candidates should be well qualified Graduate Mechanical Engineers, aged 28–35. The company is a well-established European organisation and offers good pay and conditions, with a pension scheme. There are excellent prospects for early advancement to full sales engineering responsibilities.—Apply, with full personal particulars and details of experience and previous appointments, to Dresser (Great Britain), Ltd., Clark Bros. Co. Division, 197, Knightsbridge, London, S.W.7. E2323 A

BRITISH RAILWAYS (SOUTHERN REGION) require an ELECTRICAL ENGINEERING TECHNICAL ASSISTANT in the LONDON Area for the inspection and testing of electric rolling stock and power supply equipment at Contractors' Works. Applicants should have had a sound technical training and have reached a standard of not less than that of the Ordinary National Certificate in Electrical Engineering. Manufacturing experience essential. Salary range £833–£903 per annum.—Applications in writing to be addressed to the Chief Mechanical and Electrical Engineer, British Railways (Southern Region), 15, St. Thomas Street, London Bridge, S.E.1. E5089 A

BROWN AND POLSON LTD.

largest manufacturers of maize starch and derivatives in Britain and part of an expanding international organisation, require

TRAINEE SUPERINTENDENTS

at their Manchester Plant.

Applications are invited from Graduates in Mechanical or Chemical Engineering or Applied Chemistry and from young men with minimum H.N.C. qualifications. Age up to 32.

The company's salary scales are generous and modern employee benefits and a Profit Payment Plan are in operation.

Write to :—
Personnel Adviser,
Brown & Polson Ltd.,
Trafford Park,
Manchester,

giving details of education and industrial experience. E5101 A

CATERPILLAR TRACTOR CO., LTD.

Tannochside, Uddingston,
have a vacancy for a

SALES ENGINEER

The vacancy is in the Sales Department and will interest an ambitious man aged 25–35 with good personality and a capacity for original creative thinking. Applicants should have a sound Engineering background, preferably with some experience in the contracting or earthmoving industry. Academic qualifications would be an advantage.

Duties will mainly be concerned with market problems and technical representation within the U.K. and abroad, with a possibility of field representation at a later date.

A comprehensive training will be given prior to assuming responsibilities.

The position offers excellent prospects with a progressive salary scale and there is a Superannuation and Free Life Assurance Scheme.

Write, stating full details, to Employment Manager, P.O. Box 162, Glasgow.

E5081 A

DESIGN/DRAUGHTSMEN

Applications are invited from men under 40 years of age who were apprentice trained and hold H.N.C. or equivalent, to fill vacancies in the following D.O. Sections :—

1. MECHANICAL : experience required in general mechanical design and installation, preferably of medium to heavy industrial process plant.
2. ELECTRICAL : good all-round experience desired in the installation of the electrical plant and services of a large factory.
3. WORKS SERVICES (Steam, Water and Air): for this good experience of problems involving industrial steam applications, piping and pumping systems is essential, and an H.N.C. endorsement for Heat Engines, Applied Thermodynamics or Steam Engineering is desirable.

All appointments are permanent and pensionable ; five-day, 40-hour week ; 3 weeks' annual holiday ; good working conditions. Assistance with housing given when necessary and pending removal a tax-free allowance of £4 per week is given to married men. Company pays cost removal.

Please write to SP.A Dept., MICHELIN TYRE CO., LTD., STOKE-ON-TRENT, STAFFS, quoting ref. B/E.

E5105 A

DESIGN DRAUGHTSMAN required for mechanical design of nucleonic instruments. Pleasant working conditions. Excellent rates of pay.—Apply : Chief Draughtsman, ISOTOPE DEVELOPMENTS, LTD., Beenham Grange, Aldermaston, Berks. Tel. : Woolhampton 451. E5007 A

DESIGNER-DRAUGHTSMAN, experienced in structures and mechanical handling (required by a progressive firm in the Tyneside area). Commencing salary in the range of £980 per annum, paid overtime and pension scheme in operation.—BOX No. E2311, " The Engineer." A

DESIGNER-DRAUGHTSMAN (MECHANICAL) required for Research and Development Team engaged on interesting development work in connection with special structures and diesel- and steam-operated plant. Minimum qualifications H.N.C. Age group 24–30 years. The appointment is permanent and progressive in an expanding organisation. Contributory Pension Scheme and good canteen facilities. Salary in accordance with age, qualifications and experience. The works are situated 15 (fifteen) minutes 'bus journey from the centre of Ipswich.—Applications to Personnel Officer, The British Steel Piling Company, Ltd., Claydon, Suffolk. E5011 A

DESIGNER-DRAUGHTSMAN REQUIRED for design of special purpose plant. Applicants should have practical background and several years' experience of machine design. Electrical knowledge an advantage. Work involves development of plant for rubber and plastics production. Interesting, varied work, requiring initiative and responsibility. Age group 35–50. Contributory pension scheme. —Applications to Equipment Engineer, SEMTEX LIMITED, BRYNMAWR, South Wales. E5061 A

DESIGNER - DRAUGHTSMEN. — There are unusual opportunities for several experienced Designers to join the staff of a rapidly expanding Development Division engaged in special-purpose machinery and methods. Duties include design, supervision of manufacture, installation and testing. Fully experienced men with ideas and drive offered appointments with good salaries and excellent prospects. Pension scheme.—Please write, stating salary expected and full details of experience, to Personnel Manager, DUNLOP RESEARCH CENTRE, Erdington, Birmingham, 24, quoting reference J.M.165. E5046 A

EDITOR REQUIRED for established marine journal, with a sound knowledge of the shipbuilding and ancillary industries. Non-contributory pension scheme. Only top class men should apply with full particulars of experience, age and salary required.—BOX 0370, c/o Jackson's, 54, Old Broad Street, E.C.2. E5092 A

ENGINEER/DRAUGHTSMAN REQUIRED for general mechanical engineering and engine gearbox design. Good all-round man wanted. Pension scheme.—Write, stating salary required, age and experience to FAIREY MARINE, LTD., Hamble, Hants. E5073

ENGINEERING DRAUGHTSMEN (MECHANICAL) urgently required. Applications stating age, technical qualifications, Drawing-Office experience and salary required should be addressed to : M.D.W., VICKERS-ARMSTRONGS (ENGINEERS), LTD., Barrow-in-Furness, Lancs. E5071 A

ERECTION AND CRANE MANAGER, qualified. Experience of modern methods of erection and installation essential. Capable of controlling large modern lorry-mounted cranes throughout the country, together with erectors and other tradesmen on contract work. Base South Yorks. Commencing salary £1000 p.a., plus bonus and early promotion. —BOX No. E5080, " The Engineer." A

ESTIMATOR required by PETER LIND AND CO., LTD., Romney House, Tufton Street, Westminster, S.W.1. Experienced in estimating for Civil Engineering and Reinforced Concrete work.—Apply in writing, giving age, experience and salary required. E5066 A

FINE MECHANISMS

ASSISTANT MANAGER is required by a large Midland Company for a department employing 30 men and women engaged in the production of small highly accurate components. Applicants should have had basic training in small tool making and, if possible, possess some knowledge of metallurgy and heat treatment. Initiative and a wide experience of methods of manufacture are required, with a view to the possible mechanisation of some of the skills involved. H.N.C. desirable. Successful candidate may expect to succeed present Manager on retirement in a few years' time. Applicants should reply, giving full details of education and experience.—BOX No. E5109, " The Engineer." A

FOUNDRY SALES REPRESENTATIVE REQUIRED for London and Home Counties. Applicants must be experienced in the sale of all grades of cast iron. Write, giving full details of experience, age and salary required.—BOX No. E2309, " The Engineer." A

FULLY QUALIFIED ENGINEER, to be directly responsible to the Partners, required by medium-sized firm of Consulting Engineers in Westminster. Should have had varied civil and structural engineering experience including road and bridge works. Age 35–45.—BOX No. E2303, " The Engineer." A

GENERAL ENGINEERING DRAUGHTSMAN (Senior) having experience in machine design and works layouts. A knowledge of works building design desirable but not essential. Technical education to at least O.N.C. Some assistance will be given with regard to house purchase in cases of successful applicants who are married.—Write, giving details of experience and stating age and present salary to the Personnel Manager, Ferodo, Ltd., Chapel-en-le-Frith, via Stockport. E5098 A

LIFT INSTALLATION AND SERVICE ENGINEER is required by one of the major companies operating in Commonwealth West Africa. Applicants must have had wide experience of installation and service with a lift-manufacturing company. Starting salary will not be less than £1100 p.a., in addition there are free furnished accommodation, family allowances, free medical attention, free passages and Pension fund. Tours are about 22 months followed by good home leave.—Apply, giving full details of experience and qualifications to BOX No. E5084, " The Engineer." A

HEAD ESTIMATOR required after Easter by established and steadily expanding medium weight weld-fabricating engineers in the Home Counties. Good salary with house to man with right experience. Applicants can only be considered who give in their own handwriting full details of career to date, including exact description of classes of work, present employer, and salary.—BOX No. E2307, " The Engineer." A

HEAT TRANSFER ENGINEERS are required by a company greatly extending its activities in the field of heat exchangers. Applications are invited from men experienced in the thermal and mechanical design of heat exchangers, more particularly of tubular units. The work includes overall design of a wide variety of exchangers, close liaison with customers and sub-contractors, and preparation of basic data from the results of test runs. Apply, giving full details of education and career.—BOX No. E5064, " The Engineer." A

LONDON FIRM importing Continental woodworking and plastics machinery, require active SALES ENGINEER, preferably having had experience in the woodworking industry. He should have good general engineering and electronics knowledge, and must be able to speak and understand German.—BOX No. E2320, " The Engineer." A

MANAGER

West Riding Engineering Company requires MANAGER for its Flexible Shaft Coupling Department. Applications are invited from Degree or Chartered Mechanical Engineers, preferably not above 45 years of age, with sound design and sales experience. Salary range £1500–£1750.—Write, giving full details, to Managing Director, BOX No. E2314, " The Engineer." A

MANAGER'S ASSISTANT required for small progressive Engineering Works with general works and drawing-office experience. Applicants having commercial experience and able to drive would have an advantage.—Write in first instance, stating details and salary required, to Bridge Cross Engineering Co., Ltd., Bridge Cross, Chase Terrace, Walsall, Staffs. E2318 A

MECHANICAL ENGINEER, degree or A.M.I.Mech.E., to be responsible for design and technical sales of power transmission developments, particularly couplings. Competency as a design and development engineer matched with personality and enthusiasm are essential. This is a senior appointment with commensurate salary. Excellent Life Assurance and Pension Scheme in operation. Location : Leicestershire. Write fully about your education and career in strict confidence.—BOX No. E5033, " The Engineer." A

MUNICIPAL MUTUAL INSURANCE, LIMITED, has vacancies for ENGINEER SURVEYORS in London and Birmingham. Posts are pensionable and permanent to satisfactory candidates, who should have served an apprenticeship and have sound practical and theoretical knowledge. Technical qualifications : First Class Ministry of Transport Certificate. Salary : £735–£1060 per annum.—Apply in own handwriting, marking the envelope " Application Engineer Surveyor " and " Private and Confidential," to the Chief Engineer, 22, Old Queen Street, Westminster, S.W.1. E5104 A

PROFESSIONAL ENGINEERS required, for work in connection with the application of nuclear energy for marine purposes. The work will be at Harwell for approximately six months, after which the successful applicants may be required to move to another part of the country. Only those with an Honours degree will be considered and applications giving full particulars should be sent to : The Manager, Marine Propulsion, Research and Development, VICKERS-ARMSTRONGS (ENGINEERS), LTD., Naval Construction Works, Barrow-in-Furness, Lancs. E5070 A

SENIOR DESIGN DRAUGHTSMAN required for interesting work on mechanical engineering projects. Knowledge of hydraulics an advantage.—CHAMBERLAIN INDUSTRIES, LTD., Staffa Road, Leyton, E.10. (LEY 3678). E5094 A

TRANSLATORS required. Must be British by birth and education, able to write fluent English, accustomed to handling highly technical German texts ; journalistic experience desirable.—State subjects handled, typing ability and minimum fees.—Brunton Translations, Charlotten-Str., 47, Dusseldorf, Germany. E2290 A

VAUXHALL MOTORS

has a vacancy for a

SHIFT ENGINEER

to supervise, on a rota basis with others, the operation and maintenance of the Boiler Houses and the Producer Gas Plant.

Good practical experience backed by sound theoretical knowledge, and covering both coal- and oil-fired boilers, is essential. Familiarity with diesel generating equipment would be an advantage.

Please write for an application form to—

Staff Employment Manager,
Vauxhall Motors, Ltd.,
Luton, Beds.

E5076 A

YOUNG ENGINEER required as General Editorial Assistant by publishers of established monthly technical journals. Well-qualified man, under 30, with motor industry experience preferred ; knowledge of oil engines and gas turbines an advantage. Interesting post, with travelling ; salary according experience and qualifications.—BOX No. E5059, " The Engineer." A

SITUATIONS VACANT

WORKS ENGINEER

A qualified Engineer, experienced in installation and maintenance of medium heavy mechanical and electrical equipment, for Works in Birmingham area. This is a permanent Staff appointment and a Pension Scheme is in operation. Applications should include full details of experience, age and indication of salary scale.—BOX No. E2321, "The Engineer." A

WORKS MANAGER

WORKS MANAGER required for modern works employing approximately 200, manufacturing medium and heavy machine tools and hydraulic plant. Candidates, preferably 35–40 years of age and holding Higher National Certificate, must have first class experience in workshop practice, production and labour control. Staff Pension Scheme in operation.

Applications, which will be dealt with in confidence, should give full details of qualifications, experience, positions held, and addressed to Hugh Smith and Co. (Possil), Ltd., 97, Hamiltonhill Road, Glasgow, N.2.

E5083 A

PRESSED STEEL COMPANY LIMITED

The Company is engaged in large scale manufacture of motor car bodies, commercial, domestic and industrial refrigeration plant and railway rolling stock, and employs some 18,000 people in plants at Oxford, Swindon, Reading and Paisley. It invites applications for the following appointments :—

PLASTICS TECHNOLOGIST

Highly qualified Plastics Chemist to strengthen a research and development team working on the application of plastics to the Company's products. Degree in Chemistry and experience in the research and development department of large industrial chemical company essential ; special knowledge of polyesters, polystyrenes, epoxy resins and their applications desirable. Associate Membership of Institute of Plastics an advantage. Age range up to 35 years. Location Oxford.

STRESS ENGINEER

Qualified Stress Engineer, to lead team of stressmen engaged in stress problems associated with the design and manufacture of rolling stock in light alloys. Candidates must be able to demonstrate success in solving problems of stress, strain and fatigue in large welded and riveted structures, preferably in both non-ferrous alloys and ferrous metals. Preferred age range 35/40. Location Paisley.

These openings offer opportunity to join an expanding organisation in research and development of new techniques of manufacture. Conditions of employment accord with best industrial practice. Applications, with full details of education, training, experience and salaries earned, may be made to the Personnel Director at Cowley, Oxford.

E5041 A

SITUATIONS VACANT

HARVEY

SENIOR MECHANICAL ENGINEERING DRAUGHTSMAN

required for Engineers' Department. H.N.C. standard and preferably with workshop experience of maintenance and development.

Regular employment, superannuation scheme, &c.

Apply, giving full details, to the Personnel Manager, G. A. Harvey & Co. (London) Ltd., Woolwich Road, Charlton, London, S.E.7.

E5106 A

DIESEL ENGINE DESIGN DRAUGHTSMEN

are required by the

ENGLISH ELECTRIC COMPANY
Rugby

The vacancies are for ENGINEERS of H.N.C. standard, who have served an apprenticeship connected with oil engines and who have had two or three years of drawing office practice.

Please write giving full details to Dept. C.P.S., Marconi House, 336-7, Strand, London, W.C.2, quoting reference E1199Q.

E5062 A

MECHANICAL ENGINEER

W. H. Allen Sons & Company Limited, Bedford, require a Senior Mechanical Design Engineer for their Servomechanisms and Control Systems Design Department. Applicants should have a good Degree in Mechanical Engineering and Graduate or Corporate Membership of the I.Mech.E. The preferred age range is 27 to 35.

The successful candidate will be responsible for design and development work involving control theory as applied to hydraulic-mechanical systems, including, for example, high-performance prime-mover governing. He will be expected to co-operate with other staff on projects involving the use of electro-mechanical and electronic devices. There is a well-equipped departmental laboratory.

An excellent pension scheme is in operation and assistance with removal expenses will be given.

Applications should be sent to the Personnel Manager, quoting full details of education, qualifications and experience, and stating age and present salary.

E5095 A

QUALIFIED ENGINEERS

George Angus & Co., Ltd., well-known manufacturers of "GACO" Hydraulic seals and packings, wish to make the following appointments to their Development Staff.

DEVELOPMENT ENGINEER, qualified to at least H.N.C. (Mechanical Engineering) standard, but preferably A.M.I.Mech.E. or B.Sc. Must have had several years' practical engineering experience in either production or design. It is essential that he should have the necessary initiative and personal qualities to enable him successfully to lead a development team.

RESEARCH ENGINEER, to work on problems related to fluid sealing. B.Sc. (Mechanical Engineering) essential, together with workshop training in fitting and machine shops and several years' industrial experience in design, development or research. Previous experience of fluid sealing desirable but not essential.

Only men of proved ability and initiative, who have the necessary qualifications, will be considered for these important positions, which offer attractive openings in an interesting field of engineering. Excellent staff conditions in a modern factory include Superannuation and Bonus Schemes, and consideration towards housing assistance. Written applications should be sent in confidence to the Personnel Manager, George Angus & Co., Ltd., Oil Seal Division, Coast Road, Wallsend, Northumberland.

E5090 A

SITUATIONS VACANT

DESIGN DRAUGHTSMAN

of H.N.C. standard and several years experience of test instrumentation required by

ENGLISH ELECTRIC, RUGBY

The successful applicant will be required to design complete instrumentation systems and a good knowledge of all measuring techniques is essential. Tests will mainly cover all types of prime mover.

Write giving details of experience to Dept. C.P.S., Marconi House, 336-7, Strand, London, W.C.2, quoting reference E1199P.

E5054 A

BUDENBERG GAUGE CO. LTD.,
require

A MECHANICAL ENGINEER AS ASSISTANT TO CHIEF ENGINEER

The candidate should be aged 25 to 35, have an honours degree in engineering, have served an apprenticeship and have had several years of experience in industry.

The work is extremely varied and interesting. Main duties are (1) technical applications of instruments, especially pressure gauges and thermometers, in wide fields of industry ; (2) preparing of technical specifications for embodying in tenders ; (3) designing or assisting in the design, of small mechanisms ; (4) visiting customers and users to observe instruments in use ; (5) assisting the Chief Engineer and deputising for him in his absence.

Commencing salary will depend on age, qualifications and experience. There is a favourable compulsory pension scheme. Removal assistance would be considered for a suitable candidate.

Apply in writing only, giving age, full particulars of education and experience to :

Managing Director,
Ref. C.F.B.,
Box No. 5,
Altrincham,
Cheshire.

E9983 A

SITUATIONS VACANT

DESIGNERS

with extensive experience of Bulk Material Handling Plant and Equipment required by well-known progressive Company in the North Midlands serving Coal, Quarry, Oil, Gas and Chemical Industries.

The men we are looking for will be first and foremost Structural Designers used to Stress work, coupled with familiarity with designs of Crushing, Screening, Conveying and Bulk Handling of Materials and Fluids. They will be at least H.N.C. Standard ; will have initiative, and already be earning in the region of £900–£1000.

Applicants with proved ability will be invited for early interview for which expenses will be paid.

Write, giving full chronological details of experience, &c., to BOX No. E5079, "The Engineer." A

Applications are invited for posts as

PROFESSIONAL ENGINEERS

for technical and design work on nuclear propelled vessels in the works of

VICKERS-ARMSTRONGS (ENGINEERS), LTD.,

BARROW-IN-FURNESS

Applicants should hold an Honours, Pass Degree or H.N.C. in Mechanical Engineering. Drawing-Office experience and experience in Marine Engineering will be an advantage.

A number of

DRAUGHTSMEN & TEST ENGINEERS

are also required. Salaries will be appropriate to the responsibility of the post and there is a contributory Pension and Life Assurance Scheme.

These vacancies are suitable for ambitious men who are prepared to move their homes to this area, which is pleasantly situated on the coast adjacent to the Lake District. The Company has a well-appointed Sports Club and Grounds, with comprehensive recreational facilities, both social and sporting, and in addition the town has quite a number of excellent societies which cater for practically all tastes. An illustrated guide to the town and surroundings can be sent on request.

All applications will be treated in confidence and should be addressed to :—

The Manager,

MARINE PROPULSION, RESEARCH AND DEVELOPMENT,

VICKERS-ARMSTRONGS (ENGINEERS), LTD.,

NAVAL CONSTRUCTION WORKS, BARROW-IN-FURNESS, LANCS.

5078 A

SITUATIONS WANTED

ENGINEER with 38 years' Boiler and Power House Sales and Construction experience, seeks to Represent a reputable Engineering Company on the South Coast. Salary secondary consideration.—BOX No. E2324, "The Engineer." B

STRUCTURAL ENGINEER—Steelwork, with twenty-five years' experience from Print-boy to Chief Designer, at present Branch Manager for East African territory. Returning June, 1959, seeks managerial or executive position in British Isles.—BOX No. E2312, "The Engineer." B

DRAWING & DESIGN SERVICE

SALES BROCHURES AND INSTRUCTION MANUALS, &c. Complete production service, including Design, Copy, Illustration and Printing. Specialists in Engineering Publicity.—Kingsgate Advertising, 71, Kingsgate Road, London, N.W.6. Telephone : MAIda Vale 8297. E141 B

DRAUGHTSMEN, TRACERS, &c. All Classes. Spare Time Work. Fullest details.—BOX No. E2322, "The Engineer." B

Classified Advts. continued on page 132

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

TOOLMAKING

EXTRUSION IMPACT EXTRUSION FORGING DIES
on SWISS SPARK ERODER
also Accurate Machining
Jig Boring and Planing
GIVE US YOUR DIFFICULT JOBS
LANDEN (ENGINEERS), LTD.
1A, AUBERT PARK, LONDON, N.5.
CANonbury 1075 E115 MW

FOR HIRE

LATTICE STEEL. Erection Masts (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. ('Phone, SLOane 5259). E103 K

AGENCIES

MANUFACTURERS seeking to increase their sales in Scotland may secure reliable agents by writing with particulars to the Secretaries of the Scottish Association of Manufacturers' Agents who will advertise under a box number, in the Association News Letter.—Write to Dept. E, Hourston MacFarlane and Co., 5, St. Vincent Place, Glasgow, C.1. E148 D

ENGINEERING AND ALLIED CONCERNS seeking to introduce their products at highest level to fast-growing industries and to Public Authorities in Sussex and S.E. England on Agency basis through our Sales Organisation (Principal Qualified Engineer), please write.—BOX No. E5077, "The Engineer." D

BUSINESS OPPORTUNITIES

ENQUIRIES INVITED RE A NUMBER OF PATENTED INVENTIONS concerned with electric power generation, view to manufacture under licence or sale.—BOX No. E2319, "The Engineer." O

MISCELLANEOUS

DAVIES INVESTMENTS LIMITED, Bankers, still offer 7½ per cent. on sums £20 to £500 (with-drawal on demand) with extra ½ per cent. on each £500 unit.—Details from Investment Dept., E.R. Davies Investments, Ltd., Danes Inn House, 265, Strand, London, W.C.2. E149 I

FOR SALE

600

FOUR 400 h.p. ROLLING MILL DRIVES by English Electric Co., for 440 volts, 3 phase, 50 cycles supply, each comprising slipring motor, 738 r.p.m., coupled to gearbox giving final 30 r.p.m., with barring motor, control gear, oil pumps, oil cooler, transformer available for 11,000/415 volts with switchgear.

2500kW., 440 volts, 3 phase, 50 cycles pass-out condensing STEAM TURBO-ALTERNATOR SET by British Thomson-Houston, 255 p.s.i. initially, capable of extracting 55,000 lb. or more steam/hour at pressures up to 35 lb., turbine also designed to operate fully condensing and is complete with ancillaries and switchgear.

TWO 1000kW., 3·3kV., 3 phase, 50 cycles back pressure type STEAM TURBO-ALTERNATOR SETS incorporating turbines by Belliss and Morcom, speed 4500 r.p.m., steam pressure 195 p.s.i., 380 deg. F. temperature, exhausting against 15 lb back pressure, direct coupled through David Brown gearbox ratio 4·5 : 1 to alternator by Harland Engineering Co., with direct coupled exciter, each complete set mounted on cast iron baseplate and complete with switchgear with automatic voltage regulator, also hand operated overhead crane.

700kW., 875kVA., 6·6kV., 3 phase, 50 cycles pass-out/condensing STEAM TURBO ALTERNATOR SET, comprising multi-stage turbine by Fraser and Chalmers, designed to work with steam at 180 p.s.i. initially, 420 deg. F. temperature and to pass out up to 10,000 lb. steam per hour at 30 lb. pressure, turbine complete with standard ancillaries and surface condenser and direct coupled through gearbox to alternator by General Electric Co., complete with switchgear.

TWO 450kW., 6·6kV., 3 phase, 50 cycles 4-wire DIESEL ENGINE DRIVEN ALTERNATOR SETS, direct coupled at 375 r.p.m., incorporating vertical, 6-cylinder Belliss and Morcom diesel engine, direct coupled to alternator by Metropolitan Vickers, each set complete with standard ancillaries, starting equipment and switchgear.

TWO 3000kW., 375kVA., Peter Brotherhood/General Electric Co., 400 volts, 3 phase, 50 cycles, 4-wire DIESEL ENGINE DRIVEN ALTERNATOR SETS, each mounted on baseplate and direct coupled at 750 r.p.m., each complete with standard ancillaries, starting equipment and switchgear.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070.
E200 G

FOR SALE

VALES PLANT REGISTER LIMITED
OFFER FOR IMMEDIATE SALE
CRANES

NEALS 15 cwt. "G" PETROL, 15ft. channel, pneumatics, J.A.P. petrol. £295.
NEALS 1-ton "D" MOBILE, 30ft. swan-neck, Ruston engine, pneumatics. £750.
RUSHWORTH 1½-ton Hand DERRICKS, 40ft. jibs, A.S.L.I.'s. £70 each.
RUSHWORTH 2-ton Hand DERRICK, 50ft. jib, A.S.L.I. £350.
NEALS 2-ton NM MOBILE, 35ft. swan-neck jib, Ruston engine, pneumatics. £1500.
NEALS 2-ton NM MOBILE, 30ft. jib, crawlers, Ruston engine. £1400.
JONES "Super 20" MOBILE, 24ft. jib, Lister diesel, solids. £400.
JONES "Super 22" MOBILE, 16ft. cantilever, pneumatics. £950.
VALES-REICH 3-ton 20/1300 Electrically-operated TOWER. £2750.
NEALS "NM" 3-ton MOBILE, 30ft. lattice, Ruston engine, pneumatics. £2950.
ANDERSON-GRICE 3-ton Electric DERRICK, 120ft. jib, S.L.I. £1600.
JONES KL44 4-ton MOBILE, 40ft. jib, Ruston diesel, pneumatics. December, 1955. £3300.
WILSON 5-ton STEAM LOCOMOTIVE, 50ft. lattice, 4ft. 8½in. gauge. £1700.
COLES THORNEYCROFT 5-ton LORRY MOUNTED, Mk. 7, Series 7, 40ft. jib, rope-derricking. £2800.
NEALS 4/6-ton QM MOBILE, 26ft. jib, Ruston engine, pneumatics. £2675.
COLES 6-ton Diesel/Electric MOBILE, 30ft. cantilever, pneumatics.
COLES S.88 6-ton MOBILE, 21ft. 9in. cantilever, solids, Perkins engine. £2250.
COLES 6-ton LORRY MOUNTED, rope-derricking, 17/35ft. jib. £3300.
BUTTERS 7-ton 2-motor ELECTRIC DERRICK, 120ft. jib. £2975.
MICHIGAN TMCT 16 7½-ton LORRY MOUNTED crowd shovel, dragline and 30ft. jib, Buda diesel, pneumatics. £3650.
HENDERSON 10-ton Steam DERRICK, 120ft. jib, bogies available.
SMITH 10-ton STEAM LOCOMOTIVE, 40ft. jib, 4ft. 8½in. gauge. £3500.
COLES 10-ton Fully MOBILE, 40ft. jib, Perkins engine, pneumatics. £5350.
COLES 12½-ton Fully MOBILE, 80ft. jib. £4950.

FOR A COMPREHENSIVE LIST OF PLANT FOR SALE AND HIRE—SEND FOR VALES' FREE MONTHLY PLANT REGISTER.

Further details :
14, Lower Grosvenor Place, London, S.W.1.
Telephone : VICtoria 7531, 3501, 8080, 9886 (15 lines). E107 G

TWW

PNEUMATIC POWER HAMMERS

10 cwt. MASSEY CLEAR SPACE, vee belt drive, motorised.
7 cwt. MASSEY CLEAR SPACE, vee belt drive, motorised.
7 cwt. MASSEY SLIDE TYPE, vee belt drive, motorised.
5 cwt. MASSEY SLIDE TYPE, gear drive, motorised.
2 cwt. MASSEY CLEAR SPACE, vee belt drive, motorised.
160 lb. HERCULES SPRING FORGING HAMMER by S. PLATT, cap. 4½in. round and square bars.

THOS. W. WARD LTD.
ALBION WORKS - - - SHEFFIELD
'Phone : 26311. 'Grams : "Forward."
E215 G

HYDRAULIC PRESSES

3000-ton PLATE FORMING AND BENDING PRESS, table 16ft. by 4ft. 6in., admits 10ft. 6in. between columns.
2000-ton HYDRAULIC FORGING PRESS, admits 8ft. 6in. between columns.
1000-ton HYDRAULIC FORGING PRESS by Wellman, admits 6ft. between columns.
LARGE STOCK OF HYDRAULIC PRESSES OF ALL TYPES.

REED BROTHERS (ENGINEERING), LTD.,
REPLANT WORKS,
WOOLWICH INDUSTRIAL ESTATE,
LONDON, S.E.18.
Telephone : Woolwich 7611/6. E9887 G

RICHARDS DOUBLE COLUMN VERTICAL BORER

Swings 7ft. dia. and admits about 3ft. height of work. All geared. Motorised 400/3/50.

H. BELL (MACHINE TOOLS), LTD.,
WALTER STREET, LEEDS, 4.
Tel.: 63-7398. E105 G

NEW OVERHEAD CRANES

60-ton Goliath, by Clyde, 40ft. span, 5-ton auxiliary, cab control, 400/3/50.
40-ton Goliath, by Babcock and Wilcox, 40ft. span, 5-ton auxiliary ; cab control, 400/3/50.
30-ton Adamson, 42ft. 3in. span, 5-ton aux.; new in cases.
20-ton Vaughan, 42ft. 3in. span, 6-ton aux., 17ft. lift, six available.
20-ton King, 42ft. 3in. span, unused.
10-ton Goliath, by Morris, 40ft. span, cab control, 22ft. lift, 400/3/50.
Surplus Unused Ministry Cranes, mainly still packed. Drawings on request. Inspection invited. Bargain prices.

FRED WATKINS (ENGINEERING),
LTD., COLEFORD, GLOS.
Tel.: Coleford 2271/2/3.
E132 G

FOR SALE

FRED WATKINS (ENGINEERING), LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia., 100/150 lb. w.p. ; reconditioned 8ft. 6in. down to 3ft. dia. ; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p. ; 300 reconditioned Vertical Crosstube, all sizes.
AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several others of various makes and capacities.
200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.
ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 100 h.p.
MOBILE ROAD CRANES.—10-ton Lorain lorry mounted, 30ft.–70ft. extendible jib ; 10-ton 33 R.B. track mounted 40ft. jib ; 8½-ton Ransomes Petrol/Electric, 21ft. jib ; 6-ton Coles Diesel/Electric, new 1948 (2) ; 6-ton Coles Diesel/Electric solids ; 4-ton Coles Diesel/Electric, solids, 1945 ; 4-ton Jones KL44, diesel, 1950 ; 3-ton Jones "Super 40" diesel, pneumatics (3) ; 2-ton Jones "Super 20" diesel, pneumatics.
DERRICK CRANES.—10-ton Anderson Grice steam, 120ft. jib ; 7-ton Rushworth, hand, 30ft. jib ; 5-ton Wilson Electric, 70ft. jib ; 1½-ton Anderson Grice, hand, 40ft. jib.
RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib ; 10-ton Coles steam, 40ft. jib ; 8-ton Wilson steam, 35ft. jib ; 5-ton Smith, 50ft. jib (2) ; 5-ton Cowans Sheldon, 50ft. jib.
LOCOS.—Fowler diesel, 150 h.p. (2) ; Ruston diesel, 80/88 h.p., new 1942 ; Bagnall 14in. by 22in., two oil fired, one coal ; Peckett steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge Bogies, Turnouts, &c.
STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft., 3in. black, new ; 50000ft. 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 280ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft. 60in. riveted.
CAST IRON PIPES.—Large stocks all sizes up to 24in. flanged and s.s. Immediate delivery.
VALVES.—Exceptional Surplus Ministry Lot New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock, all sizes, Parallel Slide Sluice, Gunmetal, Reducing and Check Valves. List on request.
STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.
MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¼in. ; Robertson Straightening Rolls, 8ft. 6in. by ¼in. ; Berry Bending Rolls, 7ft. by ¼in. ; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table ; Herbert 3ND Miller, 61in. by 15in. table ; Pels Punch and Shears, ¾in. capacity ; nine new 2 cwt. and 1 cwt. Pneumatic Hammers ; Bliss 14T Tapering Press ; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore ; Bigwood geared Bending and Straightening Machine up to 12in. by 6in. R.S. Joists ; two 40kVA Spot Welding Machines ; Wire Drawing Machine, 3 die up to ¾in. copper ; 50kW Electric Furnace 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone : Coleford 2271/2. E106 G

FOR SALE

LANG 15in. centre by 23ft. GAP BED LATHE ; admits 16ft. between centres ; swing 47in. by 12in. in gap.

F. J. EDWARDS LTD.,
359–361, EUSTON ROAD, LONDON, N.W.1.
EUSton 4681 and 3771.

E5065 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft. and 30ft. wide huts ; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel. : Bexleyheath 305). E113 G

FOR SALE

SERVICE EDWARDS VALUE

New BRUECK Type 20/1600, All Steel Motorised Press Brake, geared steel plate construction, arranged motor drive for 400/440/3/50, maximum pressure exerted 20 tons, former capacity 63in. by ¼in., weight approximately 36 cwt.
New MUBEA All Steel Construction Bar and Angle Shear, enclosed flywheel and gears, motorised for 400/3/50, Model KSG.100, capacity : round and square bars 2in., flat iron 10in. by ¾in., 5½in. by 1in., angles up to 4in. by ½in., 5in. by 0·425in., tee iron 5in., beams 6in., channels 6in., length of blades 12½in.
BESCO Size No. 12 Slip Roll Type B. 80½in. by 3¼in., Hand or Power Operated Geared Bending Roller, hand operated friction drive for forward or reverse motion, the top roller swings out to enable cylinders to be withdrawn, capacity in mild steel 12 S.W.G.
WESTON Model 400/100 Double Sided Friction Screw Press of welded steel plate construction, arranged motor drive for 400/3/50, pressure exerted approximately 120 tons, maximum stroke 11in., diameter of screw with four starts 6½in., weight approximately 5 tons 8 cwt.
RUSHWORTH Power Operated Double Geared Open Ended Guillotine Shearing Machine, Over-crank type, arranged for self-contained vee rope motor drive, suitable for 380/440/3/50, capacity in mild steel 4ft. by ¼in., weight approximately 50 cwt.
BIGWOOD Type PBC. 4-Roll Motorised Plate Bending and Straightening Machine, three rollers set pyramid fashion for bending and additional fourth roller for flattening, arranged motor drive 440/3/50, capacity 4ft. by ¼in., length of rolls 53½in., weight approximately 90 cwt.

Photographs of the above are available.
Very favourable Hire Purchase terms can be obtained.

MACHINE TOOLS, NEW AND USED,
Of Every Description. Attractive Prices.

F. J. EDWARDS LTD.,
359–361, EUSTON ROAD,
LONDON, N.W.1.
Telephone : EUSton 4681–3771.
and at
LANSDOWNE HOUSE, 41, WATER STREET,
BIRMINGHAM, 3.
Telephone : Central 7606–8. E207 G

600

FOUR skid-mounted, 132kVA. ROLLS-ROYCE 380/400 volts, 3-phase, 50-cycles, self-contained DIESEL - ENGINE - DRIVEN ALTERNATOR SETS, housed in sheet steel enclosure. Engine is radiator fan cooled and arranged for electric starting, and is direct coupled at 1500 r.p.m. to alternator by MACFARLANE. Each complete with switchboard.

GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: Shepherds Bush 2070.
E204 G

FOR SALE

RAILWAY TURNTABLE
For sale.—Mundt type standard gauge turntable, 65ft. long, carrying capacity 150 tons approx. Seen Chipping Sodbury.
WATER CRANE
3000 gallon water crane. Seen Chipping Sodbury.
TURNOUTS
Twenty 1 in 8 turnouts in 75 lb. F.B. rail ; interchangeable to suit L.H. or R.H.
All these items are in excellent condition.
Apply : EAGRE CONSTRUCTION CO., LTD., East Common Lane, Scunthorpe, Lincs. ('Phone : 4513.) E5100 G

FOR SALE.—6 tons capacity, All-Electric Radial Travelling Cableway by J. M. Henderson. Span 1220 feet, head mast height 120 feet, tail mast height 17 feet, with electric travel over arc of 70 deg., operating depth 250 feet.—Available after September, 1959, from The Croft Granite, Brick and Concrete Co., Ltd., Croft, Nr. Leicester. E144 G

FLAMEPROOF SOLENOID OPERATED VALVES
BUXTON CERTIFIED

Pressure Ranges ... ... 0–5" W.G.
0–5 P.S.I.
0–15 do
0–150 do
Bores ¼" to 4" ... ... 0–1500 do
Voltages D.C. 24v. to 550v.
A.C. 100v. to 600v.
WITH INTEGRAL RECTIFIERS

MAXSEAL VALVES LTD
WOOD ROAD, KINGSWOOD, BRISTOL
Phone: Bristol 67-3869

AUCTIONEERS & VALUERS

ESTABLISHED 1877

LEOPOLD FARMER & SONS

conduct

AUCTION SALES

and

VALUATIONS

OF PLANT, MACHINERY AND INDUSTRIAL PROPERTIES

FACTORY INVESTMENTS
MORTGAGES ARRANGED

46, GRESHAM STREET, LONDON, E.C.2.

Telephone : Monarch 3422 (8 lines) Telegrams : Sites, London

KNIGHT, FRANK & RUTLEY

SALE & VALUATION
OF
FACTORIES
PLANT AND MACHINERY

20, Hanover Square, W.1.

Telephone : MAYfair 3771

(Factory Department : Ext. 17)

JOHN FOORD & COMPANY

VALUERS AND ASSESSORS

OF WORKS, FACTORIES ENGINEERING PLANT AND MACHINERY

56, VICTORIA STREET, LONDON, S.W.1.

VICTORIA 2002/3/4

Established Over a Century

FOR SALE

FOR SALE, HEAVY STEEL OVERHEAD TRAVELLING CRANE GANTRY, capable of carrying two 130-ton overhead travellers ; 182ft. long, height to crane rails 30ft., box section longitudinal girders 3ft. deep, 16 stanchions of lattice box construction. Total weight 150 tons. With or without two 130-ton Electric Hydraulic Overhead Travelling Cranes, 37ft. span.

REED BROTHERS (ENGINEERING), LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone : Woolwich 7611/6.
E9821 G

FOR DISPOSAL, Quantity of Electric Motors of B.T.H. and M.V. manufacture. These are obsolete due to demolition of plant.—Interested parties should write Reference P/EB, Appleby-Frodingham Steel Co., Scunthorpe, Lincs., for details. E5060 G

AUCTIONEERS & VALUERS

RICHARDS AND PARTNERS

Auctioneers, Surveyors and Valuers

Specialists
in the
VALUATION & SALE
of
INDUSTRIAL PROPERTY
PLANT and MACHINERY

3, Arundel Street, London, W.C.2.
TEMple Bar 7471

Established 1850

WHEATLEY KIRK PRICE & CO.

E. L. JUDSON, F.R.I.C.S., F.A.I.
E. BEDDARD, A.I.MECH.E., F.A.L.P.A.
M. S. CHEAVIN, F.A.I.
G. E. GIBBS, F.A.L.P.A.

SURVEYORS, VALUERS and AUCTIONEERS of FACTORIES, PLANT and MACHINERY

FIRE LOSS ASSESSORS

9, REX PLACE, LONDON, W.1.
Telephone : HYDE PARK 8844/5/6 (3 lines)

Thirty-Sixth Sale.

E R

By Order of the Secretary of State for Air.
No. 25 MAINTENANCE UNIT, ROYAL AIR FORCE
HARTLEBURY, Worcestershire.
(4 miles from Kidderminster, 11 miles from Worcester)

Nock & Joseland

are instructed to Sell by Auction at the above Unit on
THURSDAY, 19th MARCH, 1959,
at 11 a.m. prompt,
A Large Quantity of Valuable

MISCELLANEOUS STORES

including :—
CLOTHING AND EQUIPMENT,
FOOTWEAR AND CORDAGE,
CAMERAS AND PHOTOGRAPHIC EQUIPMENT,
OFFICE FURNITURE,
RADIO AND ELECTRICAL EQUIPMENT,
GENERAL STORES.

VIEWING :—
The Lots are on View at Hartlebury on Wednesday, 18th March, 1959, between the hours of 9 a.m. and 4 p.m., and on the morning of the Sale Day between the hours of 8 a.m. and 11 a.m.

Admission only on production of catalogue, which will admit two persons on the View Day and one person on the Sale Day. The Secretary of State for Air reserves the right to refuse admission. Catalogues, price ONE SHILLING EACH (Postal Orders, NOT Stamps) can be obtained from the Auctioneers :
Nock and Joseland, Bank Buildings, Kidderminster (Tel.: 2053 and 4211). E9970 J

FOR SALE

TWO STEAM ACCUMULATORS, each 11ft. 3in. dia. by 75ft. long, 7100 cubic feet volume, maximum working pressure 250/160 lb per square inch respectively. Complete with valves, &c.—Write 2621, Wm. Porteous and Co., Glasgow. E5082 G

FOR SALE Horizontal Double-ended Batch type Furnaces with forced air circulation by Birlec for temperature range 0 deg. to 400 deg. Cent., furnace size 17ft. 6in. length by 5ft. 10in. width by 3ft. height, complete with roller tracks and all electrical accessories for 400V, 3-phase, 50 cycles.—R. S. HAYES, LTD., Bridgend, Glamorgan. Tel. No. 1311 (3 lines). E5097 G

AUCTIONEERS & VALUERS

Established 1807

FULLER, HORSEY SONS & CASSELL

Specialists
IN THE
SALE & VALUATION
OF
WORKS and MANUFACTORIES
ENGINEERING PLANT
and MACHINERY

10, LLOYD'S AVENUE
LONDON, E.C.3.

Telephone : ROYAL 4861

AUCTIONEERS & VALUERS

HENRY BUTCHER AND CO

Auctioneers, Valuers and Surveyors

Specialising
in the
SALE & VALUATION
of
ENGINEERING & ALLIED WORKS
PLANT & MACHINERY

73, Chancery Lane, London, W.C.2.

HOLBORN 8411 (8 lines)

E R

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main location	*Auctioneers*
March 9–10	**Miscellaneous stores,** including large quantity of vehicle tyres, etc.	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
March 12	**Office equipment,** including :—	Hawker Aircraft Factory, **South Shore, Blackpool.**	**LESLIE A. BUTSON** (Dept. L), 16, Birley Street, Blackpool. (Tel.: 21073.)
	Quantity of office and other furniture in good condition, including 750 oak office tables, 140 steel filing cabinets, 300 canteen tables, 2000 STACKABY chairs, index cabinets, plan chests, typists' desks, chairs, etc., also very large quantity of STORAGE RACKS, SECTIONAL STEEL BINNING AND WOODEN RACK SHELVES.		
March 17	**Machine tools, plant and miscellaneous stores,** including :—	M.O.S. Storage Depot, **Harrogate Road, Yeadon, Leeds.**	**DACRE, SON & HARTLEY** (Dept. L), Station Road, Otley, Yorks. (Tel.: 3321.)
	Lathes, grinders, pillar drills, welding plant, universal woodworking machine, bandsaws, 125-ton hydraulic press, transformers, electric motors, weighing machines, air compressors, steel unit buildings up to 150ft. long, electric trucks, stackers, auto-scythes, 80 H.P. and 150 H.P. diesel locomotives, textiles, tarpaulins, steel drums, conveyors, office furniture, etc.		
March 20	**Miscellaneous stores,** including clothing, etc.	Command Ordnance Depot, **Coypool, Marsh Mills, Plymouth.** (Sale at Kinterbury House.)	**WOOLLAND, SON & MANICO** (Dept. L), Kinterbury House, St. Andrews Cross, Plymouth. (Tel.: 65356.)
March 25	**Machine tools and miscellaneous stores.**	Technical Stores Depot, **Old Dalby, Leics.** (Sale at Melton Mowbray.)	**SHOULER & SON** (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 3081.)
April 6–10	**Vehicles, lifting and earth moving equipment, motor cycles,** etc.	M.O.S. Storage Depot, **Ruddington, Notts.**	**WALKER, WALTON & HANSON** (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
April 8	**Miscellaneous stores,** including textiles, furniture, etc.	Command Ordnance Depot, **Hilsea, Portsmouth, Hants.**	**HALL, PAIN & FOSTER** (Dept. L), 54–60, Commercial Road, Portsmouth. (Tel.: 24421/4.)

Applications for catalogues should be made *only* to the auctioneers shown above (price of catalogue 1s. 0d., P.O. only).

E118 J

FOR SALE

CHAINS

CHAINS of every type—small or large—Brass, Steel or Aluminium. Hooks, Rings and Wireforms.

A. J. PRATT & SONS, LTD.,
CHAIN HOUSE,
WOODBRIDGE STREET, LONDON, E.C.1.
CLErkenwell 3742/3.
E5049 G

FOR DISPOSAL, in first class condition—now too small for enlarged premises : 1 Tandem Corliss STEAM ENGINE by Newton, Bean and Mitchell, 1928, cylinders 12in., and 20in. bore, stroke 30in., speed 96 r.p.m. accurately controlled by "Bee" Governor, flywheel 10ft. diameter ; grooved for eight 1¼in. diameter ropes, to transmit 180 h.p. using steam at 160 lb per square inch pressure.—Offers to PEPPER, LEE AND CO., LTD., Victoria Road, Saltaire, Shipley, Yorks. Tel. : Shipley 52222. E5099 G

FOR SALE

600

COMPRESSOR SETS

2500 c.f.m. BELLISS & MORCOM 100 p.s.i. with 550 h.p. CROMPTON PARKINSON motor, 3·3kV or 400/440/3/50.
1550 c.f.m. BELLISS & MORCOM 100 p.s.i. with 328 h.p. slipring motor 400/3/50.
410 c.f.m. 120 p.s.i. BROWETT LINDLEY with LAURENCE SCOTT & ELECTROMOTORS 95 h.p. slipring motor 400/3/50.
TWO 330 c.f.m. BROOM & WADE 100 p.s.i. with BROOK 75 h.p. slipring motor, 400/3/50.

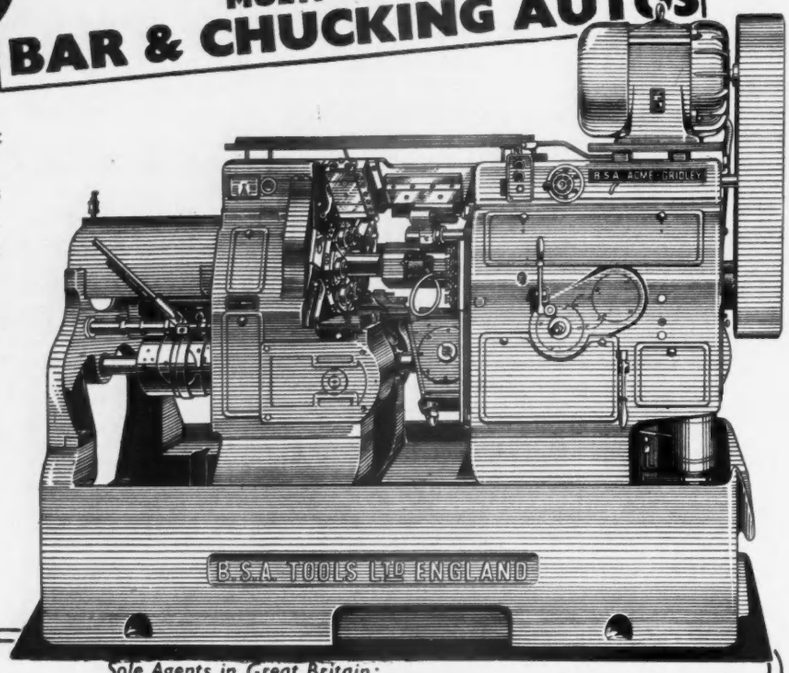
GEORGE COHEN,
SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
Tel.: SHEpherds Bush 2070, and
STANNINGLEY, Nr. LEEDS.
Tel.: Pudsey 2241. E203 G

BSA

ACME-GRIDLEY MULTI-SPINDLE BAR & CHUCKING AUTOS

These machines can be operated at the highest speeds and fastest feeds that modern cutting alloys can withstand, resulting in high output, at low cost, with constant accuracy.

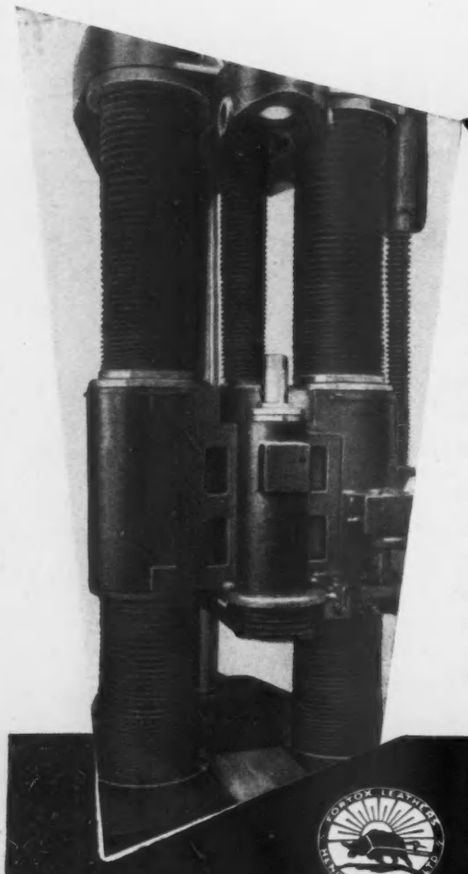
BAR MACHINES: 2¼ in. and 3½ in. (4 spindle), 7/16, 1, 1¼, 1⅝, 2⅜ in. (6 spindle), 1⅜ in. (8 spindle).
CHUCKING MACHINE: 6 in. and 7¼ in. (6 spindle).



TRADE MARKS
B·S·A TOOLS GROUP

MAKERS
B.S.A. TOOLS LIMITED
BIRMINGHAM . ENGLAND

Sole Agents in Great Britain:
BURTON GRIFFITHS & CO. LTD
KITTS GREEN, BIRMINGHAM 33
Tel: STECHFORD 3071



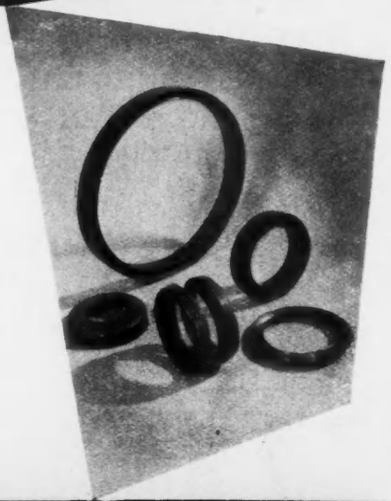
COVERS and PACKINGS

MADE TO SPECIFICATION

FORTOX FLEXIBLE COVERS protect machinery and exclude dirt. Made in neoprene-nylon, proofed leather or coated fabrics to suit all conditions. New type of construction gives expansion to contraction ratio of 10–1. Single items supplied to special requirements without tool charge.

FORTOX SEALS AND PACKINGS are manufactured to high standards of accuracy ensuring positive sealing and trouble free life. A range of polyester rubbers, silicone leathers and synthetics is available for extreme conditions. Single items supplied promptly.

Write today for full details of our work. *A.I.D. approved.*



Henry Beakbane (Fortox) Limited

HEAD OFFICE AND TANNERY
THE TANNERY · STOURPORT ON SEVERN · WORCS
TELEPHONE · STOURPORT 2017

LONDON WORKS
68 - 70 LANT ST. BOROUGH S.E.1.
TELEPHONE · HOP 0458

INDEX TO ADVERTISERS

PAGE

AB Atlas Copco/Sweden..... 11
Abingdon King Dick, Ltd..... 70
Airnesco Products, Ltd..... 86
Alldays & Onions, Ltd..... 49
Allen, E., & Co., Ltd..... 52
Allen, W. G., & Sons (Tipton), Ltd..... 104
Anderson-Grice Co., Ltd..... 105
Archdale, J., & Co., Ltd..... 88
Armstrong Patents Co., Ltd...116
Armstrong Siddeley Motors... 20
Austin, E., & Sons (London), Ltd. 36
Autometric Pumps, Ltd..... 74

B.I.P. Chemicals, Ltd..... 93
B.S.A. Tools, Ltd.....134
Barlow & Chidlaw, Ltd..... 14
Beakbane, H. (Fortox), Ltd..134
Bell's Asbestos & Engineering (Holdings), Ltd.....Cover i
Beresford, J., & Son, Ltd..... 97
Bird, W. H., & Sons, Ltd..... 58
Birkett, S., Ltd..... 49
Birmabright, Ltd.....108
Birmingham & Blackburn Construction Co., Ltd..... 39
Boby, W., & Co., Ltd..... 51
Booth, J., & Bros..... 34
Braby, F., & Co., Ltd..... 56
Brettell Lane Foundry, Ltd...135
Brett's Patent Lifter Co., Ltd. 86
Bridges, G. F., Ltd..... 58
Brightside Foundry & Engineering Co., Ltd..... 89
Brightside Plating Co., Ltd... 80
Britannia Iron & Steel Works, Ltd. 97
British Aluminium Co., Ltd... 40
British & General Tube Co., Ltd. 122
British Electrical Repairs, Ltd.101
British Jeffrey-Diamond, Ltd.101
British Paints, Ltd..... 25
Broadbent & Co. (Rochdale), Ltd. 83
Broom & Wade, Ltd.....123
Brown, D., Corporation (Sales), Ltd.....118
Brown, E. G., & Co., Ltd... 32
Brown, Lenox & Co., Ltd..... 24
Brownlie & Murray, Ltd..... 66
Burgess Products Co., Ltd..... 99
Butcher, H., & Co.....133

Callow, F. E. (Engineers), Ltd.115
Carr, C., Ltd..... 69

PAGE

Caston Barber, Ltd.....119
Chesterfield Tube Co., Ltd... 98
Ciba (A.R.L.), Ltd..... 27
Clark, G., & Sons (Hull), Ltd. 68
Clarke Chapman & Co., Ltd. 7
Clyde Blowers, Ltd..... 57
Clyde Crane & Booth, Ltd..... 34
Clyde Crane & Engineering Co. 34
Cohen, G., Sons & Co., Ltd 97
Cooper & Co, (B'ham.), Ltd. Cover ii
Cork Manufacturing Co., Ltd. Cover iv
Cowlishaw, Walker & Co., Ltd. 32
Crofts (Engineers), Ltd.....90-91
Cross Manufacturing Co. (1938), Ltd. 124
Crowthorn Engineering Co., Ltd. 66

Danks of Netherton, Ltd..... 80
Distington Engineering Co., Ltd. 61

E.N.V. Engineering Co., Ltd. 59
Eagle & Wrights (Gauges), Ltd. 106
East Lancashire Chemical Co., Ltd. 110
Electronic Engineering.....17-129
Engineering, Marine, Welding and Nuclear Energy Exhibition 54
English Abrasives Corporation, Ltd. 58
Eyre Smelting Co., Ltd..... 98

Farmer, L., & Sons.....133
Farrar Boilerworks, Ltd..... 86
Fel Electric, Ltd..... 15
Firth Brown Tools, Ltd.....111
Fisher & Ludlow, Ltd..... 21
Flexello Castors & Wheels, Ltd. 15
Fodens, Ltd..... 53
Foord, J., & Co.....133
Ford Motor Co., Ltd..... 77
Fuller, Horsey, Sons & Cassell 133

General Electric Co., Ltd..... 50
Geipel, W., Ltd..... 74
Gibson, A. L., & Co., Ltd... 85
Glenfield & Kennedy, Ltd... 84

PAGE

Goodwin, R., & Sons (Engineers), Ltd.....121
Grafton Cranes, Ltd..... 85
Greenwood's Standard Gear Cutting Co., Ltd..... 78

Hackbridge & Hewittic Electric Co., Ltd..... 22
Harbutt's Plasticine, Ltd..... 26
Harland & Wolff, Ltd..... 30
Harlow, R., & Son, Ltd..... 69
Harvey, G. A., & Co. (London), Ltd.....13
Heap, J., & Co., Ltd..... 57
Hill Alzen (Sales), Ltd..... 19
Hillside Foundry & Engineering Co. (Cupar), Ltd..... 32
Hilton, R. B., Ltd..... 10

Imperial Chemical Industries, Ltd. 110
Impregnated Diamond Products, Ltd.....102
Ince Forge Co..... 17
International Combustion Products, Ltd.....64
Ironmonger 35
Ironsides Lubricants, Ltd..... 50

Jackman, J. W., & Co., Ltd. 94

Keith Blackman, Ltd..... 8
Kempe's Engineers Year-Book 22-129
Kirk & Co. (Tubes), Ltd..... 70
Klinger, R., Ltd..... 79
Knight, Frank & Rutley.....133

Laurence, Scott & Electromotors, Ltd..... 3
Lawrie, J. & T., Ltd..... 48
Ledward & Beckett, Ltd..... 73
Lee, A., & Sons, Ltd..... 29
Leeds Engineering & Hydraulic Co., Ltd..... 53
Lister, R. A., & Co., Ltd..... 45
Loveridge, Ltd.....135

Machinery Installations, Ltd...122
McNeil, C., Ltd..... 17
Mancuna Engineering, Ltd.....121
Mather & Platt, Ltd..... 55
Matthew Hall Group of Companies 81

PAGE

Matthews & Yates, Ltd.....113
Maxseal Valves, Ltd.....132
Metal Constructions, Ltd. Cover ii
Metal Structures, Ltd.....101
Metropolitan - Cammell Carriage & Wagon Co. Ltd... 6
Metropolitan - Vickers Electrical Co., Ltd.....100
Michell Bearings, Ltd..... 57
Mills, Exors. of, J., Ltd..... 23
Mills, G. (Engineers), Ltd..... 36
Mirrlees (Engineers), Ltd..... 14
Mole, S., & Sons (Green Lane Foundry), Ltd..... 21
Mono Pumps, Ltd.....124
Morris, B. O., Ltd.....125
Mould, A. H., & Sons, Ltd... 54

National Boiler & General Insurance Co., Ltd..... 74
Neal, R. H., & Co., Ltd..... 62
Neill, J., & Co. (Sheffield), Ltd. 86
Newall, A. P., & Co., Ltd...102
Newton Chambers & Co., Ltd. 95
Niagara Screens (Gt. Britain), Ltd. 121
Non-Ferrous Die Casting Co., Ltd. 74
Norris Bros., Ltd..... 86
Northarc Organisation, Ltd...135
Norton, Sir J. Farmer & Co., Ltd. 5

Opperman Gears, Ltd..... 41
Ozonair Engineering Co., Ltd. 85

Palnut Co., Ltd..... 57
Parsons, C. A., & Co., Ltd... 12
Peglers, Ltd..... 59
Perry Chain Co., Ltd.....109
Petters, Ltd..... 60
Philips Electrical, Ltd..... 28
Phoenix-Rheinrohr, A.G..... 83
Pinchin, Johnson & Co..... 54
Platt Malleable Castings, Ltd. 66
Plus-Gas Co., Ltd..... 78
Pollard, F., & Co., Ltd..... 18
Portable Concrete Buildings, Ltd. 122
Powder Couplings, Ltd..... 6
Powis, D., & Sons, Ltd..... 26

PAGE

Precision Chains, Ltd..... 78
Price, J. T., & Co., Ltd..... 92
Priest Furnaces, Ltd..... 26

Ransome & Marles Bearing Co., Ltd.....120
Rawlplug Co., Ltd..... 15
Reavell & Co., Ltd.....119
Record Electrical Co., Ltd... 59
Redman Tools & Products, Ltd. 30
Remington Rand, Ltd..... 26
Renold Chains, Ltd.....112
Renshaw Foundry, Ltd..... 35
Research Engineers, Ltd..... 17
Reyrolle, A., & Co., Ltd..... 4
Richards & Partners.....133
Richmond Welding Co..... 86
Righton, H., & Co., Ltd.....117
Riley, A. J., & Son, Ltd..... 39
Robalio Engineering Co., Ltd.115
Robertson & Ferguson, Ltd. 5
Robson, G., & Co. (Conveyors), Ltd.....124
Rocol, Ltd.....114
Ropeways, Ltd..... 83
Rotork Engineering Co., Ltd. 94
Rubber By-Products (Warwickshire), Ltd.....101
Russell, S., & Sons, Ltd..... 17
Ruston & Hornsby, Ltd.....126

St. Georges Engineers, Ltd... 48
Sale, H. B., Ltd.....115
Saunders Valve Co., Ltd.....136
Schieldrop & Co., Ltd.....121
Schiess A.G..... 9
Shell-Mex & B.P., Ltd.....46-47
Skefko Ball Bearing Co., Ltd. 72
Small, W. H., Ltd..... 50
Smedley Bros., Ltd..... 66
Smith Bros. & Co. (Hyson), Ltd. 18
Smith, J. (Keighley), Ltd..... 16
Smith, S., & Sons (England), Ltd. 63
Smiths Industrial Instrument Division 87
South Durham Steel and Iron Co., Ltd..... 31
Southern Instruments, Ltd..... 25
Spencer (Melksham), Ltd..... 82
Sperry Gyroscope Co., Ltd... 67
Staedtler, J. S., Ltd..... 92
Steel, J. M., & Co., Ltd..... 22
Steelway, Ltd.....124

PAGE

Steels Engineering Installations, Ltd. 76
Stewarts & Lloyds, Ltd.....42-43
Stream-Line Filters, Ltd..... 94
Stubs, P., Ltd..... 73
Summerson, T., & Sons, Ltd. 77
Sunbeam Anti-Corrosives, Ltd. 69
Super Oil Seals & Gaskets, Ltd. 74
Superwelds (Lewisham), Ltd... 50

Tannahill, T., & Son, Ltd..... 2
Taylor & Hubbard, Ltd..... 49
Taylor Woodrow..... 37
Teale, J. W., Ltd..... 17
Technological Institute of Great Britain.....130
Towler Bros. (Patents), Ltd. Cover iii
Tufnol, Ltd..... 75
Twiflex Couplings, Ltd.....106

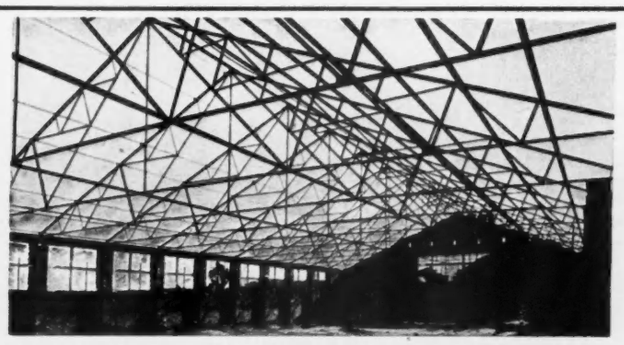
Unbrako Socket Screw Co., Ltd. 35
Universal Boilers & Engineering Co., Ltd..... 44

Visco Engineering Co., Ltd... 2
Vokes Genspring, Ltd..... 36

Wailes Dove Bitumastic, Ltd. 38
Ward, T. W., Ltd.....107
Welding Technical Services, Ltd. 105
Wellman Bibby Co., Ltd..... 18
Wellman Smith Owen Engineering Corporation, Ltd... 65
Weston, C., & Co., Ltd..... 96
Wharton Crane & Hoist Co., Ltd. 71
Wheatley Kirk Price & Co...133
Whipp & Bourne, Ltd..... 33
Wiggins, F., & Sons..... 66
Wiseman & Swain Valve Co., Ltd. 36
Wood, E., & Co., Ltd.....103

Yale & Towne Manufacturing Co. 78
Young, J. S., & Co., Ltd.....73

Zephair, Ltd..... 14



ROOF TRUSSES OR COMPLETE STEEL FRAMEWORK

FOR ALL TYPES OF INDUSTRIAL BUILDINGS Supplied Erected & Sheeted

THE NORTHARC ORGANISATION LTD

260 LANGHAM ROAD · LONDON · N.15

Tel: BOWES PARK 3757-7548

High Class GREY IRON CASTINGS

WHITE IRON AND NON - FERROUS

For all Engineering trades

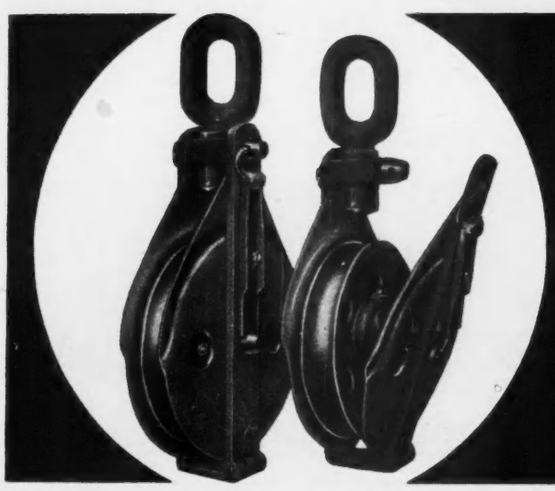
★ To B.S.S. or customer's own specifications.

★ Floor moulded up to 5 tons.

★ Machined to your drawings if required.

The BRETTELL LANE FOUNDRY LIMITED

BRIERLEY HILL, STAFFORDSHIRE · Tel: BRIERLEY HILL 7254



LOVERIDGE LTD

151-153 BUTE STREET, DOCKS, CARDIFF

Manufacturers of Patent

SNATCH BLOCKS

also PULLEY BLOCKS and

CRANE BLOCKS

for Wire Rope

Telephone: CARDIFF 23641 Send for Brochures

DIFFERENT

- - - to perform simple duties more EFFICIENTLY

SAUNDERS DIAPHRAGM VALVES

Acknowledged universally for their superiority in handling the difficult fluids of industry — the sureness of that flexible diaphragm closure and the long, trouble free life commend the valves also for scores of simple duties.

TO AVOID
WASTAGE
OF
WATER,
AIR,
GASES
AS WELL
AS THE
STILL
MORE
COSTLY
FLUIDS OF
INDUSTRY

SAUNDERS VALVE COMPANY LIMITED

DIAPHRAGM VALVE DIVISION

CWMBRAN · NEWPORT · MONMOUTHSHIRE

PRINTED BY GEORGE REVEIRS, LTD., 10/12, ROSEBERY AVENUE, LONDON, E.C.1, FOR THE PROPRIETORS, MORGAN BROTHERS (PUBLISHERS), LTD., 28, ESSEX STREET, STRAND, LONDON, W.C.2. 7/11

27 VARIETIES

The hydraulic equipment illustrated controls, in conjunction with four 280 H.P. TOWLER pump units, a 1500-ton Piercing Type Metal Extrusion Press. The rotary selectors mounted on the control desk give at least 27 *different varieties* of press speed selection.

NOTE.—All control valves are manifold mounted to minimise high-pressure pipework ; only low-pressure pilot circuit piping is visible.

Hydraulic problems are Towler's business. Whether your application involves reciprocation of one or a dozen rams, having different tonnages, speeds or dwell periods, you can rely upon Towler's to forward a satisfactory solution.

The highest engineering skill and the best materials are incorporated in Towler products resulting in effective operation of your plant year after year.

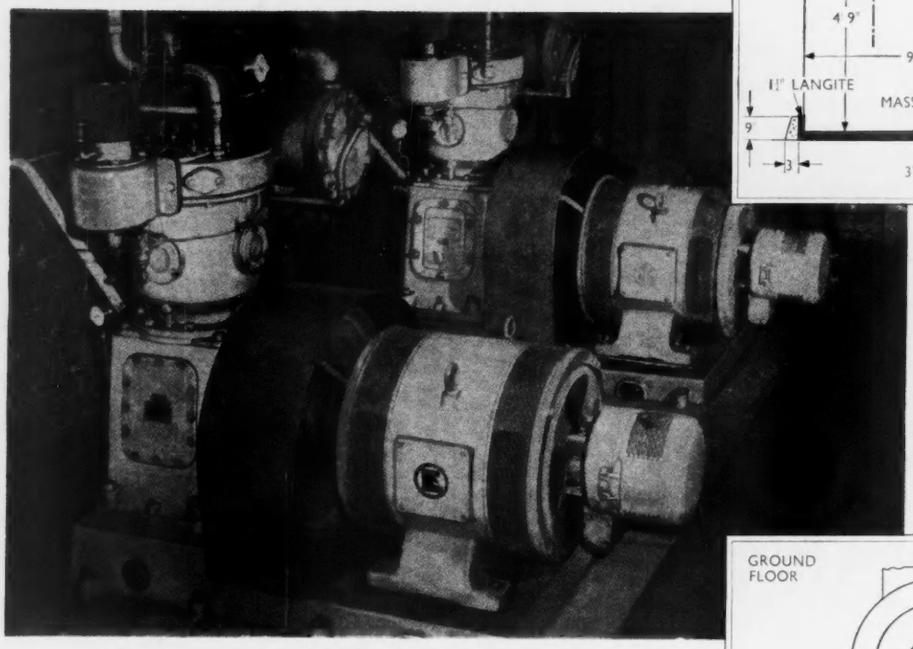
ELECTRAULIC
PUMPS
CONTROLS
AUTODRAULIC

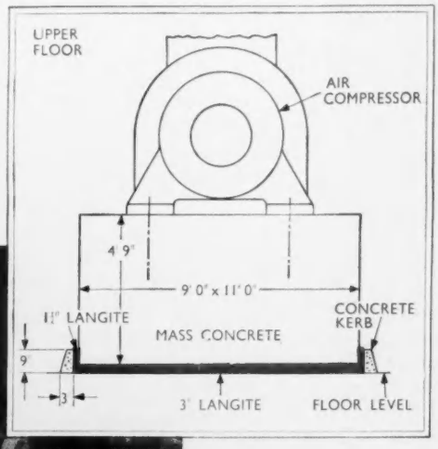
TOWLER BROTHERS (PATENTS)
LIMITED

RODLEY, NR. LEEDS, ENGLAND

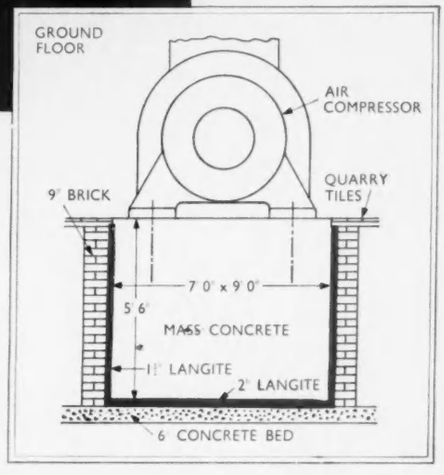
Tel: Pudsey 3125/6/7/8 **Grams: 'Electrolic' Rodley**

Isolating vibration with LANGITE





Two compressors are on the ground floor and one on an upper floor; the line drawings show the arrangement.



Vibration from compressors at The English Electric Company's works at Rugby has been effectively isolated from the rest of the building by the use of our resilient Langite '4V'.

Air compressors are a notorious source of vibration; frequency is very low (around 7 c.p.s.) and amplitude very high (around 0.01″)—a difficult combination.

Langite anti-vibration pads are supplied to: Ministry of Supply, Ministry of Works, Air Ministry, Post Office, British Railways, London Transport, Central Electricity Generating Board, British Broadcasting Corporation, London County Council, National Coal Board, U.K. Atomic Energy Authority, etc.

LANGITE

ANTI-VIBRATION PADS

CORK MANUFACTURING COMPANY LIMITED
SOUTH CHINGFORD
LONDON, E.4
Telephone:* Silverthorn 1101 *(10 lines)